
Barre Falls Dam, Massachusetts Priority Pollutant Scan

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of Engineers**
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BARRE FALLS DAM
MASSACHUSETTS
PRIORITY POLLUTANT SCAN

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BARRE FALLS DAM, MASSACHUSETTS
PRIORITY POLLUTANT SCAN

1. EXECUTIVE SUMMARY

As part of NED's continuing program of priority pollutant scans at all reservoir projects, water and sediment samples were collected from Barre Falls Dam on 22 September 1993 and analyzed for metals, PCBs, pesticides, volatile and semi-volatile organics, and dioxins. Results showed low to very low concentrations, indicative of natural background conditions. No compounds were at levels harmful to aquatic life forms likely to live in Barre Falls. Results from this priority pollutant scan can be used as a reference when evaluating other studies.

2. AUTHORITY

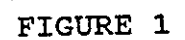
This report is prepared in accordance with ER 1130-2-415, "Water Quality Data Collection, Interpretation, and Application Activities," dated 28 October 1976; and ER 1130-2-334, "Reporting of Water Quality Management Activities at Corps Civil Works Projects," dated 30 April 1987. These regulations establish guidelines for conducting and reporting water quality control management responsibilities at Corps Civil Works facilities.

3. PROJECT DESCRIPTION

a. Location. Barre Falls Dam is located in central Massachusetts on the Ware River in the town of Barre. It is about 32 miles above the confluence of the Ware and Swift Rivers and 13 miles northwest of Worcester, Massachusetts. Figure 1 shows the location of the dam. Reservoir lands extend upstream in the Ware River drainage basin along the East Branch and its tributaries, the Stevens Branch and Longmeadow Brook, and along the West Branch into the towns of Barre, Hubbardston, Rutland and Oakham.

b. Purpose. Operation of Barre Falls Dam effectively reduces flood stages at Ware, Palmer, Ludlow, Chicopee and other potential damage centers along the Ware and Chicopee Rivers. Barre Falls Dam serves as part of the comprehensive plan of flood protection in the Connecticut River Basin. As part of this integrated operation, Barre Falls Dam reduces flood stages at potential damage centers along the Connecticut River below the mouth of the Chicopee River. Apart from its primary purpose of flood control, the Barre Falls area is utilized for sightseeing, fishing, hunting, motorcycling, picnicking, snowmobiling, and hiking. No pool is maintained behind the dam except during flood regulation events.

c. Water Quality Classification. The Cold Brook diversion is on the Ware River downstream from Barre Falls Dam. Excess Ware River flows are sent by this diversion to the Quabbin Reservoir which is the main water supply for the metropolitan Boston



area and many surrounding communities. Consequently, the Ware River as it passes through the Barre Falls project has been designated by the Massachusetts Department of Environmental Protection (MADEP) as Class A, indicating these waters are designated as a source of public water supply. To the extent compatible with this use, class A waters are excellent habitats for fish, other aquatic life, and wildlife; and are suitable for primary and secondary contact recreation. Class A waters are of excellent aesthetic value.

d. Water Quality. Barre Falls Dam is in a relatively undeveloped and rural part of Massachusetts. There are no significant point sources discharges upstream from the dam, and as the Ware River passes through the project it has generally excellent quality water which meets the requirements of Massachusetts class A standards. The principle water quality concern is low pH levels caused most likely by acid precipitation on poorly buffered Massachusetts soils and by the effects of swamps and marshes in the watershed. The water tends to be colored, due to tannins leached from upstream wetlands, and have occasional elevated coliform counts due, most likely, to visits from flocks of geese or other waterfowl. Dissolved oxygen levels are typically high, and hardness is low; the historical average for the Ware River at Barre Falls Dam is 19 ppm. The effects of Corps project operations on water quality are negligible.

e. Recreation. Recreational uses of Barre Falls Dam and the downstream areas are not intensive, in part because the Corps does not maintain an impoundment for recreation. The types of recreational activities that occur typically do not include water-contact sports. Picnicking and sight-seeing are probably most popular, but fishing, hunting, hiking, horse-back riding, canoeing, and snowmobiling are also common.

4. PRIORITY POLLUTANT SCANS

Contaminants at Corps projects are of great concern to the Corps nationwide. In response to ETL 1110-2-281 "Reservoir Contaminants" dated 17 June 1983, and Major General Wall's 3 June 1983 letter on "Potential Contamination of Corps Reservoirs," many Corps Divisions have tested for the full range of EPA priority pollutants at all projects. NED began performing priority pollutant scans in 1987 when the NED Lab achieved the ability to perform analyses for EPA organic priority pollutants. Hopkinton Lake and Birch Hill Dam were the initial projects studied in 1988. Additional projects included Northfield Brook Lake in 1989, Hop Brook Lake, and Thomaston Dam in 1991. NED intends eventually to perform such scans at all projects.

5. SAMPLING STATIONS

Water, and sediment samples were collected on 22 September 1993 by NED Environmental Laboratory personnel at stations BF02 and BF10. Station BF02 is located on the largest tributary to Barre Falls Dam, the East Branch of the Ware River, and is typical of inflow conditions. Station BF10 is located just upstream from the dam and samples materials deposited at the project. Because no permanent pool is maintained at the project, it was not expected that conditions at these stations would be significantly different. Figure 2 shows sampling station locations.

6. ANALYSES

Analyses were performed by NED's Environmental Laboratory except for dioxins and furans which were analyzed by a validated laboratory under contract.

7. RESULTS AND DISCUSSION

a. General. Appendix A contains raw data results from the priority pollutant scan. Tables 1 through 6 contain summaries of sample characteristics and detected contaminants. Tables 7 through 31 (Appendix B) contain summaries of standards for parameters found in significant concentrations at Barre Falls Dam. Appendix B tables also contain concentrations of these parameters from other sites, as an aid in determining background concentrations.

(1) Detection Limits. The first step in evaluating data is to compare results with detection limits and concentrations found in the method blanks. Parameters occurring in less than method detection limits (MDLs) were assumed not to be a problem, unless the detection limit was high compared to the standard. Parameters above MDLs were compared with levels in the method blank. Usually, concentrations in the blank were less than MDLs; however, some parameters were detected in the blank. This was a sign of sample contamination. If the level in the sample was in the same range as that in the blank, it was considered a laboratory artifact.

(2) Water Quality Standards. Parameters found in concentrations significantly higher than in the blank, were compared to standards for potable water and freshwater aquatic life, if such standards existed. For parameters with no criteria, lowest toxic concentrations (LTC) or lowest effect concentrations (LEC) were used as references, if available. Measured concentrations were then compared to levels at other locations, especially locations reported as contaminated or clean.

(3) Sediment Standards. Comprehensive standards have not been established for sediments as they have for water. In

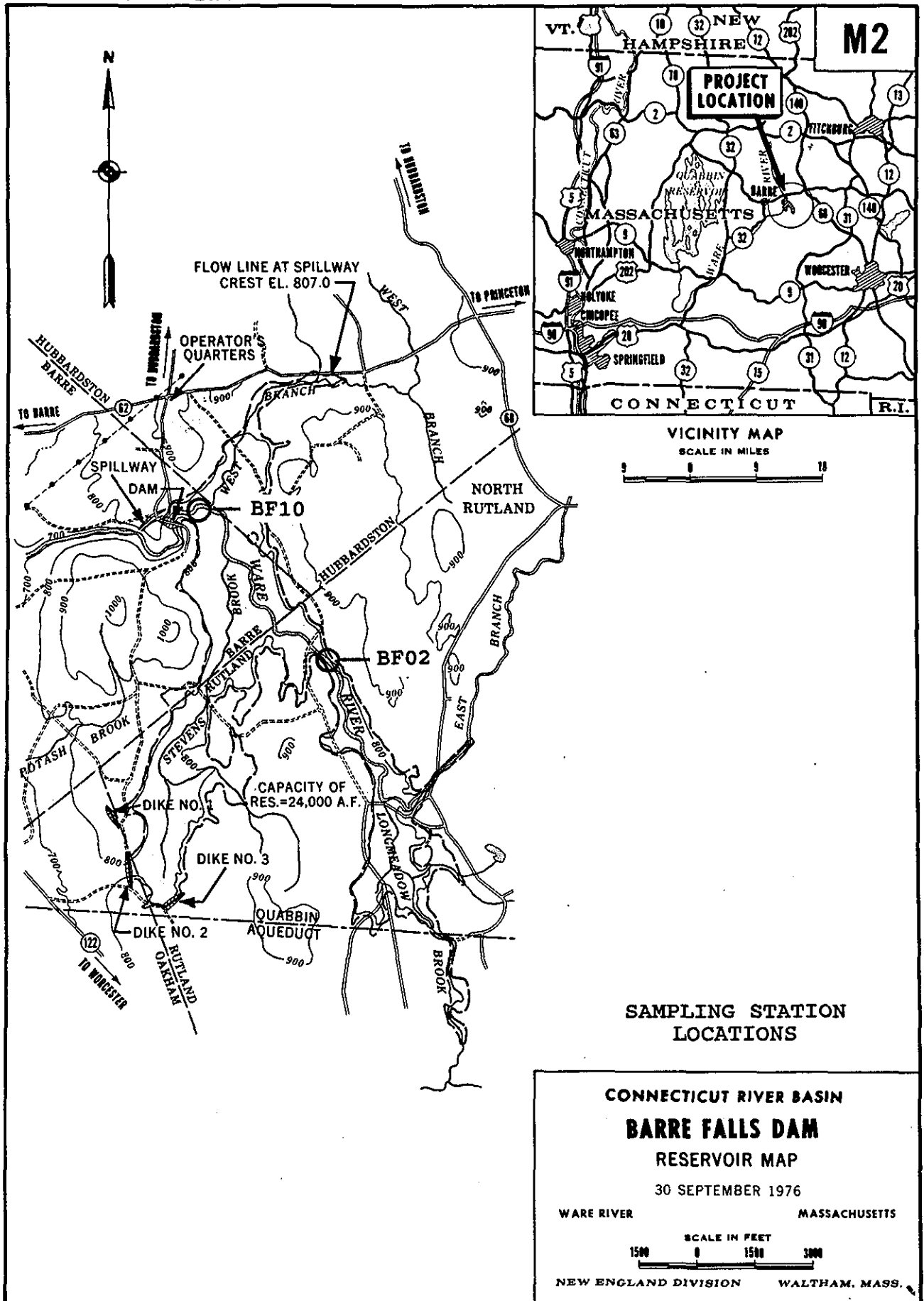


FIGURE 2

evaluating reported concentrations of parameters in sediments, the following guidelines were considered.

EPA developed guidelines for pollution classification of Great Lakes harbor sediments in 1977; however, these dealt with only 10 metals and no organic compounds other than total Kjeldahl nitrogen.

The Massachusetts Coastal Zone Management Agency developed criteria for disposal of dredged sediments (Barr, 1987). These guidelines classified dredged material into three categories; although qualitative descriptions are not given to these categories, it appears that type I are clean, type III are contaminated, and type II are lightly or potentially contaminated. These numbers are of limited usefulness because they were developed only for PCBs and nine metals.

The State of Washington developed criteria for 47 metals and compounds in sediments, including "Sediment Quality Standards" which identify surface sediments that have no adverse effects on biological resources, and "Sediment Cleanup Standards" which are the maximum degree of contamination allowed after cleanup (Ginn and Pastorok, 1992).

The National Ocean Service of the National Oceanic and Atmospheric Administration (NOAA) developed indices for potential biological effects of sediment-sorbed contaminants for a number of metals, pesticides, and polynuclear aromatic hydrocarbons (PAHs) (Long and Morgan, 1990). These indices are the ER-L, ER-M, and AET, which are explained in following paragraphs.

For some parameters, Long and Morgan also report a "sediment safe level." Based on sediment-water partition coefficients at 1 percent TOC, the "sediment safe level" is that concentration of a parameter in sediments which will not cause levels of that parameter in interstitial water to be higher than EPA water quality criteria. When there are different values for acute and chronic water quality criteria, there are different numbers for the sediment safe levels which will not cause acute and chronic criteria to be exceeded. It should be noted that EPA water quality criteria are meant more for open than interstitial waters; consequently, this method can only be used to approximate sediment criteria.

Finally, measured concentrations were compared to levels at other locations, especially sites reported as contaminated or clean.

(4) ER-L and ER-M. As explained in NOAA Technical Memorandum NOS OMA 52, The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program, by E.R. Long and L.G. Morgan, ER-L and ER-M

are statistically derived measures of sediment pollutant concentrations having effects on sensitive aquatic life. ER-L was a concentration at the low end of the range in which effects were observed; ER-M was a concentration approximately midway in the range of reported values associated with biological effects. As explained by Long and Morgan, "These values were determined using a method similar to that used by Klapow and Lewis (1979), in establishing marine water quality standards for the State of California. For each chemical of interest, they assembled available data from spiked-water bioassays, examined the distribution of the reported LC50 values, and determined the lower 10- and 50-percentile concentrations among the ranges of values. In the present document, the ER-L values were concentrations equivalent to the lower 10 percentile of the screened available data, and indicated the low end of the range of concentrations in which effects were observed or predicted. They were used in the document as the concentrations above where adverse effects may begin, or predicted among sensitive life stages and/or species or as determined in sublethal tests. The ER-M values for the chemicals were the concentrations equivalent to the 50 percentile point in the screened available data. They were used in the document as the concentration above where effects were frequently, always observed, or predicted among most species."

(5) AET. As explained by Long and Morgan, "An AET concentration is the sediment concentration of a selected chemical above which statistically significant ($P \leq 0.05$) biological effects (e.g., depressions in the abundance of benthic infauna or elevated incidence of mortality in sediment toxicity tests) always occur and, therefore, are always expected."

(6) Washington State Sediment Standards. In response to concerns about contamination in Puget Sound, the State of Washington developed criteria, for 47 metals and compounds in sediments (Ginn and Pastorok, 1992). These included "Sediment Quality Standards" which identify surface sediments that have no adverse effects on biological resources, and "Sediment Cleanup Standards" which are the maximum degree of contamination allowed after cleanup. Criteria for metals are on a dry weight basis. However, criteria for nonpolar organic compounds represent concentrations "normalized" on a total organic carbon basis. To normalize to total organic carbon, the dry weight concentration for each parameter is divided by the decimal fraction representing the percent total organic carbon content of the sediments. For example, the sediment quality standard for naphthalene is 370 ppm. If the measured concentration of naphthalene in a sediment sample is 37 ppm, and the TOC concentration in the sediment is 10 percent, then the normalized naphthalene concentration for this sample is 37 divided by 0.1 = 370 ppm. Therefore, this sample would be equal to the sediment quality standard. TOC is important in computing sediment standards because mobility of these compounds is decreased by organic matter in the

sediments. Washington State does not consider these standards as absolute and accepts that they can be modified by site-specific bioassay testing.

b. Sediment Characteristics. Table 1 summarizes sediment sample characteristics including description, grain size, and total organic carbon content (TOC). Analyses found 8.9 percent TOC at station BF02 and 3.4 percent at station BF10. These levels were used to compare contaminant levels at Barre Falls Dam to Washington sediment standards.

TABLE 1

SEDIMENT SAMPLE CHARACTERISTICS
BARRE FALLS DAM

<u>Station</u>	<u>Description</u>
BF02	Dark brown sandy silt
BF10	Dark brown sandy silt

<u>Station</u>	<u>Percent Retained on Sieve Size</u>		
	<u>75</u>	<u>50</u>	<u>25</u>
BF02	0.0155	0.0600	0.1900
BF10	0.0273	0.0700	0.2600

<u>Parameter</u>	<u>Station</u>	<u>Sample</u> <u>(percent)*</u>
Total Organic Carbon	BF02	8.9
Total Organic Carbon	BF10	3.4

*By weight of dry sample.

c. PCBs. Table 2 lists detected PCBs at Barre Falls Dam, and table 7 in appendix B summarizes standards and data.

Polychlorinated biphenyls (PCBs) represent a class of compounds that were produced by the chlorination of biphenyls and registered in the United States under the trade name, Aroclor. Chemical properties of individual Aroclors are determined by their degree of chlorination. Generally the composition of a specific Aroclor can be identified by its numerical nomenclature, e.g., Aroclor 1242, Aroclor 1254, et cetera. The first two

digits represent the molecular type, and the last two digits give the average percentage by weight of chlorine (U.S. EPA, 1976).

TABLE 2

DETECTED CONCENTRATIONS AT BARRE FALLS DAM
PCBS, DIOXINS, AND PESTICIDES

<u>Parameter</u>	<u>Station</u>	<u>Media</u>	<u>Concentration</u>	
			<u>Sample</u> (ppb)	<u>Blank</u> (ppb)
<u>PCBs</u>				
Total PCBs	BF02	Soil	36	<2.5
	BF10	Soil	42	<2.5
<u>Dioxins</u>				
Octachlorodibenzodioxins	BF10	Soil	0.032	<0.0022
<u>Pesticides</u>				
Endosulfan I	BF02	Soil	J3.8	<0.38
	BF10	Soil	<4.7	<4.7
4,4'-DDD	BF02	Soil	J5.3	<0.37
	BF10	Soil	18	<0.37

Note: J - Estimated value; analyte detected at less than the practical quantification limit.

There are no naturally occurring sources of PCBs and their presence in the environment is entirely due to anthropogenic activities. Because manufacture ended some years ago, expected sources of continuing PCBs releases to the environment include landfills containing PCBs, incineration of municipal refuse and sewage sludge, and improper disposal of PCB materials such as waste transformer fluid. However, current evidence suggests the major current source of PCB release to the environment is an environmental cycling process of PCBs previously introduced into the environment. This cycling process involves volatilization from water and soil surfaces into the atmosphere, subsequent removal from the atmosphere via wet and dry deposition, and then revolatilization (HSDB, 1994).

The persistence of PCBs in the environment depends on the degree of chlorination with the more chlorinated congeners generally being more resistant to biodegradation. Although biodegradation of higher chlorinated congeners may occur very

slowly, no other degradation mechanisms have been shown to be important in natural water and soil systems; therefore, biodegradation may be the ultimate degradation process in water and soil (HSDB, 1994).

If released to soil, PCBs adsorb tightly with adsorption, generally increasing with the degree of chlorination, and will generally not leach significantly in aqueous soil systems. PCBs released to water will be removed by adsorption to suspended particulates and sediment; but they also readily volatilize from water. PCBs have also been shown to bioconcentrate significantly in aquatic organisms. (HSDB, 1994).

No PCBs were detected in water samples and only low levels were found in soil samples from Barre Falls Dam. At station BF02, 0.036 ppm were found in the sediment sample, and 0.042 ppm were measured at station BF10; the blank sample had less than 0.0025 ppm. These levels do not indicate a health threat and are well within the range reported for background conditions.

Acute toxicity of PCBs in water to freshwater aquatic organisms probably occurs only at concentrations above 2 ppm (EPA, 1986).

Background levels of PCBs in soils have been variously reported as 0.002 to 0.5 ppm. "PCB Pollution in the New Bedford, Massachusetts Area, A Status Report" states, "There is great regional variation in the degree of PCB contamination in freshwater sediments throughout the United States. The highest PCB levels are in industrial areas, particularly in the eastern part of the country. The area from the Pacific coast to the Continental Divide has the lowest PCB level in sediments ranging from 0.0022 to 0.020 ppm. The highest 'background' values reported are in the Appalachian Mountain-Atlantic coast region where sediments with values ranging from 0.1 to 0.5 ppm have been found" (MCZM, 1983). Bidelman, et al (1981) reported finding 0.0026 ppm in sediments a South Carolina marsh; they attributed these entirely to atmospheric deposition.

In marine sediments, PCB levels less than 0.5 ppm indicate dredged material is "clean fill" according to the Massachusetts Coastal Zone Management (Barr, 1987). Guidelines for the Pollutional Classification of Great Lakes Harbor Sediments classify sediments with less than 1 ppm as unpolluted (EPA, 1977). The State of Washington set sediment quality standards of 12 ppm total PCBs and sediment cleanup standards of 65 ppm (Ginn and Pastorok, 1992).

On the other hand, Long and Morgan (1990) report that, "It appears that biological effects may begin in association with PCB concentrations above about 0.003 ppm." They report an ER-L of 0.050 and an ER-M of 0.4 ppm.

Neither EPA nor CTDEP have established criteria for PCBs in sediment. The State of Washington set sediment quality standards of 12 ppm and sediment cleanup standards of 65 ppm PCBs (Ginn and Pastorok, 1992). Assuming a sediment TOC concentration of 8.9 percent at station BF02 and 3.4 percent at station BF10, the sediment quality standards become 1.07 and 0.41, and cleanup standards become 5.79 and 2.21 ppm for BF02 and BF10, respectively.

PCBs were measured in sediments at five other NED projects: Birch Hill Dam in Massachusetts, Thomaston Dam in Connecticut, Hop Brook and West Thompson Lakes in Connecticut, and Otter Brook Lake in New Hampshire. Birch Hill Dam has sediments that are contaminated with PCBs with up to 250 ppm. Sources of these PCBs are believed to be past papermill effluents. Sediments at Thomaston Dam represent lightly contaminated conditions due to urban development and upstream discharges in its watershed; at present the river is fairly clean, but 15 or more years ago, discharges were poorly treated and the river was polluted. However, "lightly contaminated" refers to the overall condition of the sediments and not necessarily to levels of PCBs. PCB levels in two sediment samples ranged from 0.068 to 0.27 ppm (NED, 1992b). West Thompson's samples also show "lightly contaminated" sediments with respect to PCBs, although the overall condition of the sediments would classify them as contaminated. PCB levels in three sediment samples were 0.058, 0.55 and 1.0 ppm respectively (NED, 1993a). Hop Brook Lake's sediment's overall condition is lightly contaminated; PCB concentrations ranged from 0.02 to 0.09 ppm (NED, 1993c). Otter Brook's sediments are typical of clean background conditions due to the low level of development in its watershed. At Otter Brook Lake, the concentration at one station was less than the MDL of <0.0043 ppm; at the other station the measured concentration was 0.017 ppm (NED, 1992a).

In sum, it appears that measured PCB concentrations in Barre Falls Dam are typical of background concentrations. Such levels are expected to have minimal, if any, effects on fish or other aquatic life, and are well below levels requiring cleanup or remediation.

d. Dioxins and Furans. For brevity and in keeping with common usage, chlorinated dibenzodioxins are referred to in this report as "dioxins" and chlorinated dibenzofurans are referred to as "furans." It should be noted that the "dibenzofuran" included with the list of semi-volatile organic compounds is not chlorinated. Finally, it is important to note that "PCDD" and "PCDF" are acronyms for "polychlorodibenzodioxins" and "polychlorodibenzofurans," respectively, and refer to all compounds in those classes. "PeCDD" and "PeCDF" are acronyms for "pentachlorodibenzodioxins" and "pentachlorodibenzofurans," respectively.

Table 8 in Appendix B summarizes data and standards for dioxins and furans. No furans were detected at Barre Falls Dam, and the only form of dioxin in measurable quantities was 0.032 ppb of octachlorodibenzodioxin. This level is low and within the range observed for urban area soils without known sources of dioxin. This level does not represent a health threat either from contact with the material, or from consumption of fish in the area.

Dioxins and furans usually occur in the environment as a complex mixture of related isomers and congeners. Both arise as byproducts of processes which produce PCBs and other chlorinated organic compounds. Principal sources include various industrial processes (including paper manufacturing), incinerators, and forest fires. Dioxins and furans are ubiquitous in the environment, but are usually detected only in very low concentrations in the air or surface waters. These compounds are hydrophobic and adsorb strongly to sediments or suspended material, especially fine particle materials. These compounds are resistant to biodegradation, and bioconcentration in aquatic organisms has been demonstrated. Photolysis occurs in the atmosphere and, in combination with volatilization from the soil, may be the major natural destruction method (HSDB, 1993).

There are 5 forms of dioxin: tetra-, penta-, hexa-, hepta-, and octachlorodibenzodioxin. As reported by Kamrin and Rodgers (1985), and Travis et al (1989), tetrachlorodibenzodioxin (TCDD) is the most harmful and octachlorodibenzodioxin (OCDD) is the least toxic form. TCDD is generally found at the lowest levels, while OCDD is typically found at concentrations 1 to 2 orders of magnitude higher.

Table 8 (Appendix B) contains data summaries on dioxins and furans. No criteria have been established for dioxins or furans in drinking water, to protect freshwater aquatic life, or for sediments.

Concentrations of TCDD in most uncontaminated soils are below the detection limit of 0.0002 ppb (Nestrick, et al); however, soils from 15 urban sites in the United States with no obvious sources of contamination had combined dioxin plus furan (PCDD/PCDF) concentrations ranging from 0.05 to 9.1 ppb (Travis, et al, 1989). Western Lake Ontario sediment cores contained measurable TCDD levels of 0.003 to 0.013 ppb (Hallett and Brooks-bank). PCDD/PCDF levels of less than 1 ppb were found in rural locations of Michigan suggesting that atmospheric transport may carry PCDD/PCDF to remote locations. Kamrin and Rodgers (1985) reported that mean concentrations of PCDD/PCDF in sediment samples from unpolluted lakes Huron, Michigan, and Siskiwit ranged from 0.56 to 0.9 ppb; mean concentrations of OCDD in Lake Huron were 0.87 ppb and Lake Michigan were 0.90 ppb. Because of the equivalence of the mean Lake Huron and Michigan sediment

concentrations, source of these PCDD/PCDF was concluded to be atmospheric precipitation. Lake Zurich had mean sediment concentrations of 1.7 ppb PCDD/PCDF, also due to atmospheric precipitation. Hashimoto, et al (1990) reported finding dioxins in 8,120 year old sediments at concentrations up to 0.4 ppb indicating their presence before industries developed.

Concentrations of TCDD from 6 storm sewer and creek sediment samples from the Love Canal chemical dump site area in Niagara Falls, New York ranged from 0.9 to 312 ppb (Smith, R.M., et al, 1983). Analyses of soil from horse show arenas in rural Missouri where dioxin-contaminated oil was sprayed to control dust showed 31,800 to 33,000 ppb TCDD (IARC, 1973). Soil samples from Times Beach, Missouri in 1985, which had been sprayed with TCDD-contaminated waste oils in the early 1970's, contained 0.8 to 196 ppb (Freeman, R.A., et al, 1986). Kamrin and Rodgers (1985) reported PCDD/PCDF levels of 3,000 ppb in soils in Midland, Michigan close to chemical waste combustion sources.

Dioxins and furans have been measured at six other NED projects. No PCDDs or PCDFs were detected at Thomaston Dam in Connecticut (NED, 1992b), Otter Brook Lake in New Hampshire (NED, 1992a), or West Hill Dam in Massachusetts (NED, 1992d). The overall condition of Birch Hill Dam's sediments is contaminated, however, not necessarily because of their dioxin or furan content (this applies to the descriptions of other NED project sediments). Aquatic sediments within the Birch Hill reservoir contain somewhat elevated levels of dioxins and furans (NED, 1992c) which was not surprising since these sediments are contaminated with PCBs (NED, 1989). Highest detected level of any isomer was 11 ppb OCDD. Maximum detected total PCDD/PCDF concentration was 13.8 ppb. These compounds were presumably discharged along with PCBs from paper mills situated on the Otter River, upstream of the reservoir. The only compound detected in background samples was 0.41 ppb OCDD which was found at 1 of the 2 control sites.

In Connecticut, West Thompson Lake's possibly-contaminated sediments contain a variety of dioxins and furans (NED, 1993a). Highest detected level of any isomer was 5.2 ppb. Maximum detected total PCDD/PCDF concentration was 8.96 ppb. These dioxins and furans are believed to come from past upstream discharges not connected with the project.

Also in Connecticut, Hop Brook Lake's lightly contaminated sediments 2.9 ppb were detected at one station (NED, 1993c). No other isomers were detected in Hop Brook Lake sediments.

Because of their hydrophobic nature, the trace amounts normally found in the environment, and the expense of such analyses, no water samples were analyzed for dioxins or furans at Barre Falls Dam. No polychlorinated furans were detected, and

only 1 of the 5 types of dioxins were found. Table 2 summarizes results of dioxin and furan analyses.

The only form of dioxin detected at Barre Falls Dam was OCDD which was measured at 0.032 ppb in sediment from station BF10. The detection limit for this analysis was 0.022 ppb. It is within the range that has been found in uncontaminated urban soils. Maximum OCDD levels in Barre Falls sediments were about half the concentrations found at most US urban soils.

Dioxin levels at Barre Falls Dam appear to be somewhat high for clean sediments, but are within the range of background conditions. Although the level of OCDD was somewhat above mean levels for uncontaminated soils, it is within the range observed for urban U.S. soils without an obvious source of contamination. At Birch Hill Dam, a maximum of 11 ppb OCDD were found in sediments, and fish from that area had elevated levels of dioxin, but did not exceed FDA advisories (Penko, 1992). Consequently, it is very unlikely that fish at Barre Falls Dam would have high enough dioxin levels to make them unsafe for human consumption. Dioxin levels at Barre Falls Dam should have a high priority for a repeat monitoring, but are not otherwise a concern.

e. Pesticides. No pesticides were detected in water samples, but DDD and endosulfan were found in sediment samples. Levels detected were near the high end of the range of background conditions, probably because of agricultural activities in the watershed. However, concentrations were not so high as to indicate unusual or harmful conditions.

(1) Endosulfan. Table 9 in Appendix B summarizes standards and data for Endosulfan.

The primary use of endosulfan is as an insecticide. It is used against a variety of insects on a variety of crops. Technical endosulfan is composed of both alpha-endosulfan and beta-endosulfan. Endosulfan isomers on the soil surface may photolyze. When released to the water, endosulfan isomers are expected to hydrolyze readily, more so under alkaline conditions. It is stable in sunlight and slowly oxidizes in air. Endosulfan may also bioconcentrate in organisms. Isomers of endosulfan are contaminants in air, water, sediment, soil, fish and other aquatic organisms, and food (HSDB, 1993).

The primary target of action of Endosulfan is the central nervous system. It is poisonous and may be fatal if inhaled, swallowed or absorbed through the skin. Contact can cause burning to the skin and eyes. Endosulfan can be absorbed by inhalation, ingestion and or contact with the skin or eyes. The estimated lethal oral dose for humans is in the range of 50 to 500 ppm (HSDB, 1993).

EPA set acute freshwater aquatic life criteria for endosulfan at 0.22 ppb and chronic freshwater aquatic life at 0.056 ppb.

There are no standards for endosulfan in soils or sediments. Long and Morgan have not reported any effects threshold for endosulfan in marine sediments.

Endosulfan was not detected in water samples from other NED projects. However, at West Thompson Lake in Connecticut, sediments were analyzed for endosulfan at three stations and results ranged from less than 1.9 to 5.7 ppb (NED, 1993a). At Otter Brook Lake in New Hampshire, both sediment samples had less than the MDL of 3.5 ppb (NED, 1992a). At Thomaston Dam in Connecticut, sediment endosulfan levels from two stations were less than the MDLs, which ranged from 8.4 to 16 ppb (NED, 1992b).

It is difficult to interpret the above data to develop reference levels for evaluating sediment concentrations at Barre Falls Dam. However, it appears that sediment endosulfan levels below 1 ppb are not likely to harm aquatic organisms, and levels below 5 ppb are probably within the range of background conditions.

Endosulfan was less than the MDL of 4.7 ppb in sediment at station BF10; at station BF02, endosulfan was detected but below the PQL of 3.8 ppb. These levels are too close to the method detection limits to evaluate accurately. Agricultural activity--the most likely source of Endosulfan--is not intensive in the watershed and there are no indications that aquatic life at Barre Falls Dam are being harmed by anthropogenic compounds. Consequently, it is concluded that these levels are within the estimated range of background conditions and not a concern at this project.

(2) DDD. Table 10 in appendix B summarizes standards and data for DDD.

DDD was used as an insecticide before it was banned in the early 1970s, and is a metabolic breakdown product of DDT. There are no natural sources of DDD. Therefore, any traces of DDD are residuals from earlier uses. DDD absorbs strongly to sediments, particularly fine grained or organic sediments. Consequently, it is rarely detected in water. DDD does not readily volatilize from soils, but is subject to photolysis if exposed to sunlight. It bioconcentrates, but biodegrades very slowly if at all (HSDB, 1993).

Levels of DDD were found at both sediment stations at Barre Falls Dam. At station BF02, the concentration of DDD was estimated to be 5.3 ppb. At station BF10, the level of DDD in the sediment was found to be 18 ppb.

There are no standards for DDD or DDT in drinking water. EPA has set criteria to protect sensitive aquatic organisms from DDT and its metabolites in water at 1.1 ppb for acute conditions and 0.0010 ppb for chronic conditions (USEPA, 1976). However, EPA has proposed changing these to 0.0067 ppb for chronic conditions and 0.021 for acute (HSDB, 1993).

There are no standards for DDD in soils or sediments. Long and Morgan (1990) report apparent effects thresholds for DDD in marine sediments ranging from 2 to 43 ppb. They report an ER-L of 2 and an ER-M of 20 ppb. The sediment safe level based upon sediment/water partitioning coefficients (at 1 percent TOC) was 3,250 ppb for acute water quality criteria.

DDD was not detected in water samples from other NED projects did; however, it was detected in some sediments. West Thompson Lake, in Connecticut, has sediments whose overall condition is possibly-contaminated, although not necessarily due to DDD levels. Measurements there found a range from less than 1.7 ppb to 740 ppb (NED, 1993a). Thomaston Dam, also in Connecticut, has sediments whose overall condition is lightly contaminated; analyses for DDD at 2 stations found 9.1 ppb at one, and 24 ppb at the other (NED, 1992b). Hop Brook Lake is the third Connecticut project reporting detectable levels. The overall condition of this project's sediments is lightly contaminated; DDD measurements ranged from an estimated 5.3 to 18 ppb (NED, 1993c). Otter Brook Lake, in New Hampshire, has clean sediments; DDD measurements at two stations there found one station had 8 ppb, and the second station examined had less than the MDL of 6.9 ppb (NED, 1992a).

The U.S. Rivers National Water Summary of 1984 reported DDD was detected in bed material, collected between 1975-80, at 31 percent of the 171 sites and in 12 percent of the 990 samples examined (Harris and Sans, 1971).

The U.S. National Soils Monitoring Program in FY92 examined 1,487 samples from 37 states and detected DDD in 7.8 percent at levels ranging from 10 to 38,460 ppb with a mean of 50 ppb (Feltz, 1980). In FY71, 380 samples were examined from 5 cities. All cities had detectable levels and 42 percent of the 380 samples had 10 to 6,570 ppb with an average of 100 ppb (Carey, et al., 1978). Another study of 50 samples taken from each of 8 cities detected DDD in 18 to 84 percent, with an overall range of 10 to 5,060 ppb and an overall average of 120 ppb (Wiersma, et al., 1972).

Staples, et al (1985) examined the U.S. EPA STORET database and found that of 1,087 samples analyzed, DDD was detected in 60 percent with a median of 0.2 ppb.

The DDD content of undisturbed sediments off the southern coast of California were examined by Callahan, et al (1979). By means of radio dating of the sediment layers, they determined DDD began to appear around 1955 at 12 ppb and attained 18 ppb levels by 1976.

Two researchers examined Lake Michigan sediments for DDD. Schacht (1974) found 0.01 to 12.6 ppb with a mean of 3.04 ppb. Carey, et al (1980) found 0.02 to 5.47 ppb with a mean of 1.01 ppb.

Gilliom, (1985) examined 25 samples at 13 sites in the Potomac River basin. Of these, DDD was detected in 52 percent at levels ranging from 0.8 to 640 ppb with an average of 104 ppb.

Carey, et al (1980) examined U.S. rice growing areas in 5 states and detected DDD in all samples with a range of 10 to 940 ppb and an average of 50 ppb. While a study of Japanese field soils found 18 to 1,554 ppb (Suzuki, et al. 1974).

It is difficult to interpret the above data to come up with a "background level" for this ubiquitous contaminant. However, as a rough guide, it appears that two definitions can be given for background levels for DDD: "high quality" and "normal." "High quality background levels" would apply to watersheds that received DDE only from atmospheric deposition, and sediments from these areas would be expected to have less than 10 ppb DDD. "Normal background levels" would apply to watersheds without widespread applications of DDD, and sediments from these areas would be expected to have less than 100 ppb. By these definitions, sediments with background levels of DDD could still have adverse effects on aquatic life, because even the 10 ppb background level is greater than the ER-L of 2 ppb. However, DDD is so widespread that it is unrealistic to expect to find fine-grained sediments with levels so low as to have no effects on aquatic life. Because of the nature of Barre Falls Dam's watershed, sediment DDD levels should be compared to the 10 ppb high quality background level.

The maximum concentration of 18 ppb of DDD at Barre Falls Dam in sediments at station BF10 is well below the 3,250 ppb that would cause acute water quality criteria to be exceeded in interstitial water based on sediment-water partitioning. On the other hand, the 18 ppb DDD at this station is greater than the 2 ppb ER-L developed by Long and Morgan; although it is less than the 20 ppb ER-M. This indicates that some adverse effects on aquatic life would be expected for sensitive organisms exposed to these sediments. The maximum of 18 ppb DDD at Barre Falls Dam was within the range of 9.1 to 24 ppb observed at Thomaston Dam and the 5.3 to 18 ppb at Hop Brook Lake in Connecticut. The maximum at Barre Falls Dam was far below the 740 ppb measured in possibly-contaminated sediment from West Thompson Lake in Con-

necticut. Also, the maximum at Barre Falls Dam was not much above the 8 ppb maximum measured at Otter Brook Lake in New Hampshire. Finally, the maximum measured at Barre Falls Dam is well within the range of median levels observed in soils across the United States by various researchers. On the whole, the level at BF10 appears to exceed the estimated range for high quality background conditions, but is within the normal background range and not a cause for concern. The absence of detectable levels of DDT or DDE is further indication that DDD is not a concern at this project.

f. Trace Metals in Soils. Table 3 is a summary of trace metals in soils at Barre Falls Dam. There are no Federal or State criteria for bulk metal levels in soils. Most metals analyzed were detected in soils, which would be expected. Levels of all metals were higher at the station BF02 than station BF10 because of the higher organic content at station BF02; metals tend to bind to organic compounds. Metals levels at both stations are typical of background conditions.

(1) Arsenic. Table 11 in appendix B summarizes standards and data for arsenic.

Elemental arsenic is insoluble in water but many of its salts are highly soluble. In some parts of the western U.S., arsenic compounds naturally occur (McKee & Wolf). Naturally occurring levels of arsenic in the earth's crustal soils have been variously reported as 1.81 (Aherns), 2 (EPA, 1977), and 6 ppm (Lisk, 1972). A survey of arsenic in Ontario soils where no arsenical insecticides were used reported means of 5.84 \pm 4.60 ppm in sandy soils and 6.43 \pm 3.69 ppm in clay soils (Frank et al, 1976). Arsenic levels in dredged harbors in the Gulf of Maine (NED, 1980a) for 598 cases averaged 6.98 mg/Kg and the mean plus two standard deviations was 22.3 mg/Kg. For 598 cases in dredged harbors from Cape Cod to Western Connecticut, the mean arsenic level was 7.3 mg/Kg and the mean plus 2 standard deviations was 24.7 mg/Kg. An analysis of arsenic in the sediments from 16 lakes in Massachusetts found a mean of 14.1 mg/Kg and a range of 0.7 to 43 mg/Kg (Fratoni et al, 1972).

Neither EPA nor MADEP have established criteria for arsenic in sediment. The Great Lakes Guidelines (EPA, 1977) define nonpolluted sediment as having less than 3 mg/Kg, moderately polluted as having 3-8 mg/Kg, and heavily polluted as having more than 8 mg/Kg of arsenic. The Massachusetts Dredging Handbook gives Type I, II, and III classifications for disposal of dredged material; for arsenic, type I, II, III limits are <10, 10 to 20, and >20 ppm, respectively (Barr, 1987). The State of Washington set sediment quality standards of 57 ppm arsenic and sediment cleanup standards of 93 ppm (Ginn and Pastorok, 1992).

TABLE 3

DETECTED CONCENTRATIONS AT BARRE FALLS DAM
TRACE METALS IN SOIL

<u>Parameter</u>	<u>Station</u>	<u>Media</u>	<u>Concentration</u>	
			<u>Sample</u> (ppm)	<u>Blank</u> (ppm)
Arsenic	BF02	Soil	5.4	<0.20
Arsenic	BF10	Soil	2.4	
Beryllium	BF02	Soil	4.2	<0.023
Beryllium	BF10	Soil	0.14	
Cadmium	BF02	Soil	0.93	<0.17
Cadmium	BF10	Soil	0.51	
Chromium	BF02	Soil	16	<0.72
Chromium	BF10	Soil	8.2	
Copper	BF02	Soil	11	<0.32
Copper	BF10	Soil	4.8	
Lead	BF02	Soil	28	<0.20
Lead	BF10	Soil	21	
Nickel	BF02	Soil	14	<0.56
Nickel	BF10	Soil	4.8	
Selenium	BF02	Soil	J1.5	J0.30
Selenium	BF10	Soil	J0.68	
Thallium	BF02	Soil	<0.51	<0.30
Thallium	BF10	Soil	J0.51	
Zinc	BF02	Soil	63	<0.39
Zinc	BF10	Soil	29	

Notes:

J - Estimated value; analyte detected at less than the Practical Quantification Limit.

The heavily polluted French River in Connecticut had a mean of 16.65 and a range of 2.1 to 31.4 ppm arsenic in its sediments (NED, 1979). Arsenic measurements in sediments from the highly polluted Ashtabula River in Ohio had a mean of 28.9 and a range of 12 to 56 mg/Kg (Leonard, 1986). Sediments from the polluted Oxoboxo River in Connecticut had a mean of 11 and a range of 8 to 16 mg/Kg arsenic (NED, 1980b), while the relatively unpolluted Oak Orchard Harbor, New York, sediments had arsenic levels varying from 2.1 to 5.7 with a mean of 3.2 mg/Kg (Smith et al, 1984). Unpolluted Winnepesaukee River sediments had 2.3 to 2.6 mg/Kg (Wood, 1984). It should be noted that pollution classifications of these waters are based on their overall condition and not just the arsenic content of either the water or sediments.

Median arsenic levels found in sediments in the 1975 Massachusetts Toxic Element Survey (Isaac and Delaney, 1975) ranged from 3 mg/Kg in the heavily polluted Blackstone River, to 0.8 mg/Kg in the moderately polluted North River, to 4.2 mg/Kg in the lightly polluted Quinsigamond River, to 0.2 mg/Kg in the clean South River. Maximum arsenic levels in this study were 20, 4.4, 9.0, and 0.4 mg/Kg, respectively from heavily polluted to clean. Sediments from Lake Quinsigamond, which was considered clean, had the highest level of arsenic recorded in this study: the median was 37 and the maximum was 94 mg/Kg. For many of the metals included in this survey, the Lake Quinsigamond sediments had levels as high or higher than the heavily polluted Blackstone River sediments. This is probably due to lake sediments being more likely to trap and retain arsenic. Fuller (1977) classified arsenic as only slowly mobile in soils. However, it should also be remembered that these rivers were classified as polluted based on their general condition and not necessarily their arsenic contents.

Long and Morgan (1990) reported an ER-L of 33, AET of 50, and an ER-M of 85 ppm with a low degree of confidence in the ER-L but moderate confidence in ER-M. Kesler-Arnold and O'Hearn (1990) found background levels in Lower Michigan soils had a range of 0.006 to 39 ppm with a mean of 6.2 ppm.

Arsenic was detected in sediments at a number of other NED projects. Arsenic measurements were made on 4 samples from contaminated sediments collected from Birch Hill Dam in Massachusetts; results ranged from 0.9 to 2.5 with a mean of 1.9 ppm (NED, 1988b). Three samples of possibly-contaminated sediments from West Thompson Lake, in Connecticut, had 11 to 48 ppm (NED, 1993a). At Thomaston Dam, in Connecticut, 1.4 to 1.7 ppm were found in lightly contaminated sediment samples from 2 stations (NED, 1992b). Hop Brook Lake, in Connecticut, also has lightly contaminated sediments; arsenic analyses of two sediments found 0.88 to 2.2 ppm (NED, 1993c). Two New Hampshire projects with clean sediments were examined: Hopkinton Lake had 2.3 to 3.9 ppm

(NED, 1988a), and Otter Brook Lake had 0.6 to 0.7 ppm (NED, 1992a). The average of the mean arsenic concentrations for all other NED projects was 5.6 ppm. It should be noted that pollution classifications of these sediments are based on their overall condition and not just their arsenic content.

Arsenic levels in Barre Falls Dam soils ranged from 5.4 to 2.4 ppm. These levels are low and in the range of unpolluted soils. The absence of detectable concentrations in the waters of Barre Falls Dam is further evidence that arsenic is not a concern at this project.

(2) Beryllium. Table 12 in appendix B summarizes standards and data for beryllium.

A relatively rare metal in the earth's crust (average concentration 50 ppm), beryllium is rarely found in surface waters because of the insolubility of the carbonate and hydroxide salts (McKee and Wolf). There are no drinking water, aquatic life, or sediment criteria for beryllium. Kesler-Arnold and O'Hearn (1990) found background levels in Lower Michigan soils had a range from less than 0.1 to 1.4 ppm with a mean of 0.5 ppm.

Beryllium was detected in sediments at a number of other NED projects. Three samples of possibly-contaminated sediments from West Thompson Lake, in Connecticut, had 1.1 to 2.1 ppm (NED, 1993a). At Thomaston Dam, in Connecticut, 0.56 to 0.78 ppm were found in lightly contaminated sediment samples from 2 stations (NED, 1992b). Hop Brook Lake, in Connecticut, also has lightly contaminated sediments; beryllium analyses of two sediments found 0.17 to 1.8 ppm (NED, 1993c). Beryllium levels in Otter Brook Lake's clean sediments, in New Hampshire, ranged from 0.45 ppm at one station to less than quantifiable but estimated at 0.55 ppm at the second. The average of the mean beryllium concentrations for all other NED projects was 0.91 ppm. It should be noted that pollution classifications of these sediments are based on their overall condition and not just their beryllium content. In Barre Falls sediments, concentrations ranged from 0.14 to 4.2 ppm. These levels are within the expected range for background concentrations and typical of levels observed at other NED projects. In sum, beryllium levels are low and do not appear to be a cause for concern at this project.

(3) Cadmium. Table 13 in appendix B summarizes standards and data for cadmium.

Biologically, cadmium is a nonessential, nonbeneficial element recognized to be of high toxic potential. It is deposited and accumulated in various body tissues and is found in varying concentration throughout all areas where man lives. Within the past decades industrial production and use of cadmium have increased with a concomitant increase in acute cases of cad-

miosis. Cadmium, by itself or in conjunction with other agents, may cause a variety of human ailments including tumors, kidney disorders, high blood pressure, arteriosclerosis, chronic diseases of old age, and cancer (EPA, 1976). Cadmium is used as a metallurgical alloy, in electroplating ceramics, pigmentation, and photography. Cadmium salts have been used as insecticides and antihelminthics (McKee and Wolf).

Naturally occurring levels of cadmium in the earth's crustal soils have been variously reported as 0.2 (Berry and Mason, 1959; Aherns, 1975), 0.3 (Bini, et al. 1988), 0.06 to 0.50 (Ryan et al, 1980), and 0.01 to 0.70 mg/Kg (Baker and Chesnin, 1975). Barrett (1980) reported that most of the country has less than 0.2 ppm cadmium in soils and that few soils have greater than 1 ppm cadmium. Kesler-Arnold and O'Hearn (1990) found background levels in Lower Michigan soils had a range from <0.025 to 4.1 ppm with a mean of 0.9 ppm. Miller and McFee (1983) examined surficial soil samples from 5 areas of industrialized northwestern Indiana; cadmium levels ranged from 17.6 in urban soils to 0.6 ppm in rural soils. At a depth of 30 to 36 centimeters, all soil samples had 0.1 to 0.2 ppm cadmium.

Cadmium levels in dredged harbors in the Gulf of Maine (NED, 1980a) for 597 cases averaged 3.12 mg/Kg and the mean plus two standard deviations was 15.6 mg/Kg. For 601 cases for the dredged harbors from Cape Cod to Western Connecticut, the mean cadmium level was 5.9 mg/Kg and the mean plus 2 standard deviations was 26.9 mg/Kg. An analysis of cadmium in the sediments from 16 lakes in Massachusetts found a mean of 2.6 mg/Kg and a maximum of 7.1 mg/Kg (Fratoni et al, 1982).

Neither EPA nor MADEP have established criteria for cadmium in sediment. The Great Lakes Guidelines (EPA, 1977) define any sediment with greater than 6 mg/Kg of cadmium as polluted. No limits for moderately polluted or nonpolluted sediments were established. The Massachusetts Dredging Handbook gives Type I, II, and III classifications for disposal of dredged material; for cadmium, type I, II, III limits are <5, 5 to 10, and >10 ppm, respectively (Barr, 1987). The State of Washington set sediment quality standards of 5.1 ppm cadmium and sediment cleanup standards of 6.7 ppm (Ginn and Pastorok, 1992). Assuming a TOC concentration of 8.9 percent at station BF02 and 3.4 percent at station BF10, the sediment quality standards become 0.45 and 0.17, and the cleanup standards become 0.6 and 0.23 for BF02 and BF10 respectively.

Long and Morgan (1990) reported an ER-L of 5, AET of 5, and an ER-M of 9 ppm with a high degree of confidence in the ER-L and ER-M.

The heavily polluted French River in Connecticut had a mean of 7.35 and a range of 0.7 to 25 ppm cadmium in its sediments (NED, 1979). Cadmium measurements in sediments from the highly polluted Ashtabula River in Ohio had a mean of 6.1 and a range of 5 to 9 mg/Kg (Leonard, 1986). Polluted Oxoboxo River sediments in Connecticut had from less than 2 to 14 mg/Kg with a mean of less than 9 mg/Kg cadmium (NED, 1980b) while the relatively unpolluted Oak Orchard Harbor, New York, sediments had cadmium levels varying from 0.6 to 2.4 with a mean of 2.1 mg/Kg (Smith et al, 1984). It should be noted that the pollutional classifications of these waters are based on their overall condition and not just the cadmium content of either the water or sediments.

Median cadmium levels found in sediments in the 1975 Massachusetts Toxic Element Survey (Isaac and Delaney, 1975) ranged from 17 mg/Kg in the heavily polluted Blackstone River, to 0.9 mg/Kg in the moderately polluted North River, to 0.3 mg/Kg in the lightly polluted Quinsigamond River, to 0.2 mg/Kg in the clean South River. Maximum cadmium levels in this study followed the same neat progression from 150 mg/Kg to 5.5, 0.6, and 0.3 mg/Kg, respectively from heavily polluted to clean. Lake Quinsigamond, which was considered clean, had sediments with a median of 2.9 mg/Kg and a maximum of 5.5 mg/Kg of cadmium. That clean Lake Quinsigamond had sediments with cadmium levels in the range of moderately polluted to heavily polluted river sediments is not too surprising since lake sediments seem to be more likely to trap and retain metals. Fuller (1977) classified cadmium as only slowly mobile in soils due to its tendency to form insoluble precipitates in oxidizing conditions. Also, it should be remembered that these rivers were classified as polluted based on their general condition and not necessarily their cadmium contents.

Cadmium was detected in sediments at a number of other NED projects. Cadmium measurements were made on 4 samples from contaminated sediments collected from Birch Hill Dam in Massachusetts; results ranged from 0.4 to 1.0 with a mean of 0.6 ppm (NED, 1988b). Three samples of possibly-contaminated sediments from West Thompson Lake, in Connecticut, had 0.88 to 22 ppm (NED, 1993a). At Thomaston Dam, in Connecticut, cadmium levels were too low to quantify, but were estimated to range from 1.2 to 3.6 ppm in lightly contaminated sediment samples from 2 stations (NED, 1992b). Hop Brook Lake, in Connecticut, also has lightly contaminated sediments; cadmium analyses of two sediments found 3.4 ppm at one station and less than the MDL of 0.50 ppm at the other (NED, 1993c). Two New Hampshire projects with clean sediments were examined: cadmium was not detected at Hopkinton Lake (NED, 1988a), and Otter Brook Lake had less than the PQLs of at 0.43 to 1.2 ppm at two stations (NED, 1992a). The average of the mean cadmium concentrations for all other NED projects was 3.3 ppm. It should be noted that pollution classifications of

these sediments are based on their overall condition and not just their cadmium content.

In Barre Falls Dam sediments, concentrations ranged from 0.93 at station BF02 to 0.51 ppm at station BF10. These levels are below the ER-L, ER-M, and AET; met Washington State and Massachusetts DEQE standards for unpolluted sediments; and was within the range observed for background concentrations and at other NED projects. Sediment cadmium concentrations are not a concern at this project.

(4) Chromium. Table 14 in appendix B summarizes standards and data for chromium.

Although chromium has oxidation states ranging from Cr^{-2} to Cr^{+6} , the trivalent form is found most commonly in nature, and the hexavalent form is the most toxic. Chromium is found in air, soil, some foods, and most biological systems; it is recognized as an essential trace element for humans (EPA, 1976). Hexavalent chromium salts are used extensively in metal pickling and plating operations, in anodizing aluminum, in the leather industry as a tanning agent, in the manufacture of paints, dyes, explosives, ceramics, paper, and many other substances. Trivalent chromium salts, on the other hand, are used much less extensively, being employed as mordants in textile dyeing, in the ceramic and glass industries, and in photography. Chromium compounds are also used as corrosion inhibitors in cooling waters (McKee and Wolf).

Chromium is the 17th most abundant nongaseous element in the earth's crust (EPA, 1976). Naturally occurring levels of chromium in the earth's crustal soils have been variously reported as 80 (EPA, 1976), 100 (Aherns, 1975), 200 (Berry and Mason, 1959), and 5 to 3000 mg/Kg (Allaway, 1968). Schacklette (1971) found that American soils may contain 1 to 1,500 ppm. Kesler-Arnold and O'Hearn (1990) found background levels in Lower Michigan soils had a range of 0.56 to 58 ppm with a mean of 11.8 ppm. Krauskopf (1979) found the average abundance of chromium in shale was 100 ppm. Chromium levels in dredged harbors in the Gulf of Maine (NED, 1980a) for 597 cases averaged 112 mg/Kg and the mean plus two standard deviations was 563 mg/Kg. For 598 cases for the dredged harbors from Cape Cod to Western Connecticut, the mean chromium level was 160 mg/Kg and the mean plus 2 standard deviations was 783 mg/Kg. An analysis of chromium in the sediments from 16 lakes in Massachusetts found a mean of 36 mg/Kg and a range of 5 to 150 mg/Kg (Fratoni et al, 1982).

Neither EPA nor MADEP have established criteria for chromium in sediment. The Great Lakes Guidelines (EPA, 1977) define nonpolluted sediment as having less than 25 mg/Kg, moderately polluted as having 25 to 75 mg/Kg, and heavily polluted as having more than 75 mg/Kg of chromium. The Massachusetts Dredg-

ing Handbook gives Type I, II, and III classifications for disposal of dredged material; for chromium, type I, II, III limits are <100, 100 to 300, and >300 ppm, respectively (Barr, 1987). The State of Washington set sediment quality standards of 260 ppm chromium and sediment cleanup standards of 270 ppm (Ginn and Pastorok, 1992). Assuming a TOC concentration of 8.9 percent at station BF02 and 3.4 percent at station BF10, the sediment quality standards become 23.14 and 8.84, and cleanup standards become 24.03 and 9.18 for BF02 and BF10 respectively.

Long and Morgan (1990) reported an AET of 260 to 370 ppm, an ER-L of 80, and an ER-M of 145 ppm with a moderate degree of confidence in the ER-L and ER-M.

Heavily polluted sediments from impoundments in the French River in Connecticut had a mean of 1,370 and a range of 23 to 4710 ppm chromium (NED, 1979). The highly polluted Ashtabula River in Ohio had 64 to 629 mg/Kg with a mean of 312 mg/Kg of chromium in its sediments (Leonard, 1986). Polluted Oxoboxo River sediments in Connecticut had 34 to 83 mg/Kg with a mean of 61.6 mg/Kg chromium (NED, 1980b), while the relatively unpolluted Oak Orchard Harbor, New York, sediments had a mean chromium level of 1.2 mg/Kg and a range of 6.4 to 9.5 mg/Kg (Smith et al, 1984). Clean Winnepesaukee River sediments had 12 to 13 mg/Kg chromium (Wood, 1984). It should be noted that pollutional classifications of these bodies of water and sediments were based on their overall condition and not just the chromium content of either the water or sediments.

Median chromium levels found in sediments in the 1975 Massachusetts Toxic Element Survey (Isaac and Delaney, 1975) ranged from 130 mg/Kg in the heavily polluted Blackstone River, to 9.8 mg/Kg in the moderately polluted North River, to 16 mg/Kg in the lightly polluted Quinsigamond River, to 6.2 mg/Kg in the clean South River. Maximum chromium levels in this study were 900, 363, 40 and 7.5 mg/Kg, respectively, from heavily polluted to clean. Lake Quinsigamond, which was considered clean, had sediments with a median of 34 mg/Kg and a maximum of 73 mg/Kg of chromium. That clean Lake Quinsigamond had sediments with chromium levels in the range of slightly polluted to heavily polluted river sediments is not surprising since lake sediments seem to be more likely to trap and retain metals. Also, it should be remembered that these rivers were classified as polluted based on their general condition and not necessarily their chromium contents. Fuller (1977) classified chromium as only slowly mobile in soils due to its tendency to form insoluble precipitates in oxidizing conditions.

Chromium was detected in sediments at a number of other NED projects. Chromium measurements were made on 4 samples from contaminated sediments collected from Birch Hill Dam in Massachusetts; results ranged from 4.4 to 24.9 with a mean of 10.3 ppm

(NED, 1988b). Three samples of possibly-contaminated sediments from West Thompson Lake, in Connecticut, had 54 to 320 ppm (NED, 1993a). At Thomaston Dam, in Connecticut, 26 to 52 ppm were found in lightly contaminated sediment samples from 2 stations (NED, 1992b). Hop Brook Lake, in Connecticut, also has lightly contaminated sediments; chromium analyses of two sediments found less than 4.6 to 48 ppm (NED, 1993c). Two New Hampshire projects with clean sediments were examined: Hopkinton Lake had 22 to 32 ppm (NED, 1988a), and Otter Brook Lake had 16 to 40 ppm (NED, 1992a). The average of the mean chromium concentrations for all other NED projects was 48 ppm. It should be noted that pollution classifications of these sediments are based on their overall condition and not just their chromium content.

With a range of 8.2 to 16 and a mean of 12.1 ppm, chromium levels at Barre Falls Dam meet Washington State and Massachusetts DEQE standards for unpolluted sediments, and are below the ER-L and ER-M, are within the range observed at other NED projects, and are within the range reported for background concentrations in Michigan soils. Both samples are within the range of unpolluted sediments for the Great Lakes Sediment guidelines. Chromium levels in Barre Falls Dam sediments appear to be due to natural processes in the watershed. The absence of detectable chromium in the waters of Barre Falls Dam is a further indication that chromium is not a concern at this project.

(5) Copper. Table 15 in appendix B summarizes standards and data for copper.

Copper salts occur in natural surface waters only in trace amounts, up to about 0.05 mg/l. Consequently, their presence is generally the result of pollution, attributable to corrosive action of water on copper and brass tubing, to industrial effluents, or frequently to use of copper compounds for the control of undesirable plankton organisms (McKee and Wolf). Copper is an essential trace element for the propagation of plants and is required in animal metabolism (EPA, 1986).

Uses for copper include electrical products, coins, and metal plating. Copper frequently is alloyed with other metals to form various brasses and bronzes. Oxides and sulfates of copper are used for pesticides, algicides, and fungicides. Copper frequently is incorporated into paints and wood preservatives to inhibit growth of algae and invertebrate organisms (EPA, 1986).

Naturally occurring levels of copper in the earth's crustal soils have been variously reported as 45 (Berry and Mason, 1959), 55 (Aherns, 1975), and 2 to 100 mg/Kg (Allaway, 1968). Kesler-Arnold and O'Hearn (1990) found background levels in Lower Michigan soils had a range from less than 0.1 to 74 ppm with a mean of 12.6 ppm. A survey of Ontario agricultural soils found a mean of 65 ppm in organic soils, 20 ppm in sandy soils,

and 25.4 ppm overall (Frank et al, 1976). Miller and McFee (1983) examined surficial soil samples from 5 areas of industrialized northwestern Indiana; copper levels ranged from 212 in urban soils to 75 ppm in rural soils. At a depth of 30 to 36 centimeters, all soil samples had 1.5 to 3.7 ppm copper.

Copper levels in dredged harbors in the Gulf of Maine (NED, 1980a) for 591 cases averaged 83 mg/Kg and the mean plus two standard deviations were 342 mg/Kg. For 601 cases for the dredged harbors from Cape Cod to Western Connecticut, the mean copper level was 260 mg/Kg and the mean plus 2 standard deviations was 1330 mg/Kg. An analysis of copper in the sediments from 16 lakes in Massachusetts found a mean of 284 mg/Kg and a range of 20 to 940 mg/Kg (Fratoni et al, 1982).

A study of precipitated copper in lake bottom mud resulting from copper sulfate application to control nuisance algae concluded that the toxic limit to a midge and a fingernail clam was about 9,000 mg/Kg of copper in mud on a dry weight basis (EPA, 1976).

Neither EPA nor MADEP have established criteria for copper in sediment. The Great Lakes Guidelines (EPA, 1977) define nonpolluted sediment as having less than 25 mg/Kg, moderately polluted as having 25 to 50 mg/Kg, and heavily polluted as having more than 50 mg/Kg of copper. The Massachusetts Dredging Handbook gives Type I, II, and III classifications for disposal of dredged material; for copper, type I, II, III limits are <200, 200 to 400, and >400 ppm, respectively (Barr, 1987).

The State of Washington set sediment quality standards of 390 ppm chromium and sediment cleanup standards of 390 ppm (Ginn and Pastorok, 1992). Assuming a TOC concentration of 8.9 percent at station BF02 and 3.4 percent at station BF10, the sediment quality standards become 34.71 and 13.26, and cleanup standards become 34.71 and 13.26 for BF02 and BF10 respectively.

Long and Morgan (1990) reported an ER-L of 70, AET of 300, and an ER-M of 390 ppm with a high degree of confidence in the ER-L and ER-M.

Heavily polluted sediments from the French River in Connecticut had a mean copper concentration of 541 ppm and a range of 5 to 1790 ppm (NED, 1979). The highly polluted Ashtabula River in Ohio had a mean of 48.7 mg/Kg and a range of 34 to 69 mg/Kg of copper in its sediments (Leonard, 1986). Polluted Oxoboxo River sediments in Connecticut had 170 to 350 with a mean of 275 mg/Kg copper (NED, 1980b), while the relatively unpolluted Oak Orchard Harbor, New York, sediments had copper levels varying from 13 to 80 with a mean of 23 mg/Kg (Smith et al, 1984). Unpolluted Winnepesaukee River sediments had 13 to 15 mg/Kg of copper (Wood, 1984). It should be noted that when

describing these rivers as "polluted" or "nonpolluted" reference is made to the overall condition of the river and not necessarily the heavy metals content of its sediments or even the river water.

Median copper levels found in sediments in the 1975 Massachusetts Toxic Element Survey (Isaac and Delaney, 1975) ranged from 320 mg/Kg in the heavily polluted Blackstone River, to 15 mg/Kg in the moderately polluted North River, to 13 mg/Kg in the lightly polluted Quinsigamond River, to 6.0 mg/Kg in the clean South River. Maximum copper levels in this study followed the same neat progression from 1850 mg/Kg to 635, 21, and 8.4 mg/Kg, respectively, from heavily polluted to clean. Lake Quinsigamond, which was considered clean, had sediments with a median of 94 mg/Kg and a maximum of 180 mg/Kg of copper. That clean Lake Quinsigamond had sediments with copper levels in the range of moderately polluted to heavily polluted river sediments is not surprising since lake sediments seem to be more likely to trap and retain metals. Also, it should be remembered that these rivers were classified as polluted based on their general condition and not necessarily their copper contents. Fuller (1977) classifies copper as moderately mobile in soils as he found it was absorbed more strongly by soil than other moderately mobile metals such as iron, lead, and zinc, but its complexes were less stable.

Copper was detected in sediments at a number of other NED projects. Copper measurements were made on 4 samples from contaminated sediments collected from Birch Hill Dam in Massachusetts; results ranged from 6.4 to 40.5 with a mean of 24.5 ppm (NED, 1988b). Three samples of possibly-contaminated sediments from West Thompson Lake, in Connecticut, had 30 to 170 ppm (NED, 1993a). At Thomaston Dam, in Connecticut, 51 to 110 ppm were found in lightly contaminated sediment samples from 2 stations (NED, 1992b). Hop Brook Lake, in Connecticut, also has lightly contaminated sediments; copper analyses of two sediments found 13 to 39 ppm (NED, 1993c). Two New Hampshire projects with clean sediments were examined: Hopkinton Lake had 25 to 25.5 ppm (NED, 1988a), and Otter Brook Lake had 3.6 to 13 ppm (NED, 1992a). The average of the mean copper concentrations for all other NED projects was 45 ppm. It should be noted that pollution classifications of these sediments are based on their overall condition and not just their copper content.

With a range of 4.8 to 11 and a mean of 7.9 ppm, copper levels at Barre Falls Dam meet the Washington State, Massachusetts DEQE, and Great Lakes Sediment Guidelines for unpolluted sediments; are below the ER-L, ER-M, and AET; are within the range found at other NED projects; and are within the range of naturally occurring unpolluted soils. The absence of detectable copper in the waters of Barre Falls Dam is a further indication that copper is not a concern at this project.

(6) Lead. Table 16 in appendix B summarizes standards and data for lead.

Lead has no beneficial or desirable nutritional effects as it is a toxic metal that tends to accumulate in the tissues of man and other animals. In addition to their natural occurrence, lead and its compounds may enter and contaminate the environment through mining, smelting, processing, and usage especially through automobile exhaust. Lead enters the aquatic environment through precipitation, lead dust fallout, erosion and leaching of soil, municipal and industrial waste discharges, and runoff of fallout deposits from streets and other surfaces (EPA, 1976).

Certain lead salts, such as acetate and chloride, are readily soluble, but owing to the fact that the carbonate and hydroxide are insoluble and the sulfate is only sparingly soluble, lead will not remain long in natural waters (McKee and Wolf).

Naturally occurring levels of lead in the earth's crustal soils have been variously reported as 12.5 (Aherns, 1975), 16 (Lisk, 1980), a mean of 10 with a range of 2 to 200 mg/Kg (Allaway, 1968), and a mean of 15 with a range of 1 to 200 mg/Kg (Swaine, 1955). A study of the total lead content of soils in this country found an average of 16 ppm and a range of 10 to 700 ppm (Lisk, 1980). Kesler-Arnold and O'Hearn (1990) found background levels in Lower Michigan soils had a range from less than 0.5 to 140 ppm with a mean of 10.3 ppm. Krauskopf reported the average abundance of lead in shale was 20 ppm. Miller and McFee (1983) examined surficial soil samples from 5 areas of industrialized north-western Indiana; lead levels ranged from 755 in urban soils to 163 ppm in rural soils. At a depth of 30 to 36 centimeters, all soil samples had 0.2 to 0.9 ppm lead. Friedland, et al (1992) examined lead in forest floor samples from New England and New York; he found a mean level of 146 ppm in 1980 and 121 ppm in 1990.

Lead levels in dredged harbors in the Gulf of Maine (NED, 1980a) for 598 cases averaged 83 mg/Kg and the mean plus two standard deviations was 285 mg/Kg. For 601 cases for the dredged harbors from Cape Cod to Western Connecticut, the mean lead level was 145 mg/Kg and the mean plus 2 standard deviations was 711 mg/Kg. An analysis of lead in the sediments from 16 lakes in Massachusetts found a mean of 274 mg/Kg and a range of 72 to 970 mg/Kg (Fratoni et al, 1982).

Neither EPA nor MADEP have established criteria for lead in sediment. The Great Lakes Guidelines (EPA, 1977) define nonpolluted sediment as having less than 90 mg/Kg, moderately polluted as having 90 to 200 mg/Kg, and heavily polluted as having more than 200 mg/Kg of lead. The Massachusetts Dredging Handbook gives Type I, II, and III classifications for disposal

of dredged material; for lead, type I, II, III limits are <100, 100 to 200, and >200 ppm, respectively (Barr, 1987). The State of Washington set sediment quality standards of 450 ppm lead and sediment cleanup standards of 530 ppm (Ginn and Pastorok, 1992). Assuming a TOC concentration of 8.9 percent at station BF02 and 3.4 percent at station BF10, sediment quality standards become 40.05 and 15.3, and cleanup standards become 47.17 and 18.02 for BF02 and BF10 respectively.

Long and Morgan (1990) reported an ER-L of 35, AET of 300, and an ER-M of 110 ppm with a moderate degree of confidence in the ER-L and a high degree in the ER-M.

Heavily polluted sediments from the French River in Connecticut had a mean of 358 mg/Kg of lead and a range of 13 to 840 mg/Kg (NED, 1979). The highly polluted Ashtabula River in Ohio had 38 to 89 with a mean of 63.5 mg/Kg of lead in its sediments (Leonard, 1986). Polluted Oxoboxo River sediments in Connecticut had 12 to 340 with a mean of 187 mg/Kg lead (NED, 1980b), while the relatively unpolluted Oak Orchard Harbor, New York, sediments had lead levels varying from 6.4 to 34 with a mean of 13.9 mg/Kg (Smith et al, 1984). Unpolluted Winnepesaukee River sediments had 88 to 93 mg/Kg (Wood, 1984). It should be noted that when describing these rivers as "polluted" or "nonpolluted" reference is made to the overall condition of the river and not necessarily the heavy metal content of its sediments or even the river water.

Median lead levels found in sediments in the 1975 Massachusetts Toxic Element Survey (Isaac and Delaney, 1975) ranged from 200 mg/Kg in the heavily polluted Blackstone River, to 50 mg/Kg in the moderately polluted North River, to 45 mg/Kg in the lightly polluted Quinsigamond River, to 18 mg/Kg in the clean South River. Maximum lead levels in this study followed the same neat progression from 980 mg/Kg to 300, 120, and 50 mg/Kg, respectively, from heavily polluted to clean. Lake Quinsigamond, which was considered clean, had sediments with a median of 265 mg/Kg and a maximum of 400 mg/Kg of lead. That clean Lake Quinsigamond had sediments with lead levels in the range of heavily polluted river sediments is not surprising since lake sediments seem to be more likely to trap and retain metals. Also, it should be remembered that these rivers were classified as polluted based on their general condition and not necessarily their lead contents. Fuller classified lead as moderately mobile in soils; he found it was absorbed more strongly by soil than other moderately mobile metals such as iron and zinc, but its complexes were less stable.

Lead was detected in sediments at a number of other NED projects. Lead measurements were made on 4 samples from contaminated sediments collected from Birch Hill Dam in Massachusetts; results ranged from 22.1 to 78.6 with a mean of 46.3 ppm (NED,

1988b). Three samples of possibly-contaminated sediments from West Thompson Lake, in Connecticut, had 68 to 1500 ppm (NED, 1993a). At Thomaston Dam, in Connecticut, 37 to 86 ppm were found in lightly contaminated sediment samples from 2 stations (NED, 1992b). Hop Brook Lake, in Connecticut, also has lightly contaminated sediments; lead analyses of two sediments found 16 to 58 ppm (NED, 1993c). Two New Hampshire projects with clean sediments were examined: Hopkinton Lake had 65.8 to 73.4 ppm (NED, 1988a), and Otter Brook Lake had 8.2 to 16 ppm (NED, 1992a). The average of the mean lead concentrations for all other NED projects was 144 ppm. It should be noted that pollution classifications of these sediments are based on their overall condition and not just their lead content.

With a range of 21 to 28 ppm, and a mean of 24.5 ppm, lead levels at Barre Falls Dam meet the Washington State and Massachusetts DEQE standards for unpolluted sediments. These levels are also below the ER-M, ER-L and AET; The lead levels at both stations BF02 and BF10 place the samples in the unpolluted category of the Great Lakes Sediment Guide- lines. The lead concentrations in both samples are in the range found at most other NED projects, well below the mean found in northeast forest floors, within the range found of background levels in Michigan soils, and within the range found in sediments in unpolluted rivers. The absence of detectable lead in the waters of Barre Falls Dam is a further indication that lead levels in sediments are not a concern at this project.

(7) Nickel. Table 17 in appendix B summarizes standards and data for nickel.

Nickel is considered to be relatively nontoxic to man, and a limit for nickel is not included in the EPA National Primary Drinking Water Regulations. Studies of the toxicity of nickel to aquatic life indicate that tolerances vary widely and are influenced by species, pH, synergistic effects, and other factors (EPA, 1976).

Nickel compounds are found in many ores and minerals. As a pure metal it is not a problem in water pollution because it is not affected by, or soluble in, water. However, many nickel salts are highly soluble in water and, since they are used in metal-plating works, they may be discharged to ground or surface waters (McKee and Wolf).

Naturally occurring nickel levels in the earth's soils have been variously reported as 40 (Lisk, 1980), 75 (Aherns, 1975), and 80 mg/Kg (Berry and Mason, 1959); a mean of 10 with a range of 2 to 200 mg/Kg (Allaway, 1968); and a mean of 15 with a range of 1 to 200 mg/Kg (Swaine, 1955). A study of the total nickel content of soils in this country found an average of 20 ppm and a range of 45 to 70 ppm (Isaac and Delaney, 1975).

Kesler-Arnold and O'Hearn (1990) found background levels in Lower Michigan soils had a range from less than 0.25 to 53 ppm with a mean of 14.2 ppm.

Nickel levels in dredged harbors in the Gulf of Maine (NED, 1980a) for 598 cases averaged 36 mg/Kg and the mean plus two standard deviations was 92 mg/Kg. For 600 cases for the dredged harbors from Cape Cod to Western Connecticut, the mean nickel level was 49 mg/Kg and the mean plus 2 standard deviations was 139 mg/Kg. An analysis of nickel in the sediments from 16 lakes in Massachusetts found a mean of 56 mg/Kg and a range of 20 to 201 mg/Kg (Fratoni, 1975).

Neither EPA nor MADEP have established criteria for nickel in sediment. The Great Lakes Guidelines (EPA, 1977) define nonpolluted sediment as having less than 20 mg/Kg, moderately polluted as having 20 to 50 mg/Kg, and heavily polluted as having more than 50 mg/Kg of nickel. The Massachusetts Dredging Handbook gives Type I, II, and III classifications for disposal of dredged material; for nickel, type I, II, III limits are <50 , 50 to 100 and >100 ppm, respectively (Barr, 1987).

Long and Morgan (1990) reported an AET of 28 to 170, an ER-L of 30, and an ER-M of 50 ppm with a moderate degree of confidence in the ER-L and ER-M.

Heavily polluted sediments from the French River in Connecticut had a mean nickel concentration of 28.5 and a range of 9.9 to 50.9 ppm (NED, 1979). Highly polluted Ashtabula River in Ohio had 28 to 63 with a mean of 44.1 mg/Kg of nickel in its sediments (Leonard, 1986). Polluted Oxoboxo River sediments in Connecticut had 20 to 40 with a mean of 30 mg/Kg nickel (NED, 1980b), while the relatively unpolluted Oak Orchard Harbor, New York, sediments had nickel levels varying from 14 to 20 with a mean of 18 mg/Kg (Smith et al, 1984). Nickel levels in unpolluted Winnepesaukee River sediments were less than MDLs (Wood, 1984). When describing these rivers as "polluted" or "nonpolluted," reference is made to the overall condition of the river and not necessarily the heavy metals content of its sediments or even the river water.

Median nickel levels found in sediments in the 1975 Massachusetts Toxic Element Survey (Isaac and Delaney, 1975) ranged from 68 mg/Kg in the heavily polluted Blackstone River, to 8.1 mg/Kg in the moderately polluted North River, to 16 mg/Kg in the lightly polluted Quinsigamond River, to 3.6 mg/Kg in the clean South River. Maximum nickel levels in this study ranged from 320 to 32, 64, and 4.2 mg/Kg, respectively, from heavily polluted to clean. Lake Quinsigamond, which was considered clean, had sediments with a median of 46 mg/Kg and a maximum of 48 mg/Kg of nickel. It should be remembered that these rivers

were classified as polluted based on their general condition and not necessarily their heavy metals contents.

Nickel was detected in sediments at a number of other NED projects. Nickel measurements were made on 4 samples from contaminated sediments collected from Birch Hill Dam in Massachusetts; results ranged from 5 to 12.3 with a mean of 9 ppm (NED, 1988b). Three samples of possibly-contaminated sediments from West Thompson Lake, in Connecticut, had 10 to 56 ppm (NED, 1993a). At Thomaston Dam, in Connecticut, estimated levels of 31 to 38 ppm were found in lightly contaminated sediment samples from 2 stations (NED, 1992b). Hop Brook Lake, in Connecticut, also has lightly contaminated sediments; nickel analyses of two sediments found estimated levels of 5.1 to 31 ppm (NED, 1993c). Two New Hampshire projects with clean sediments were examined: Hopkinton Lake had 11 to 15 ppm (NED, 1988a), and Otter Brook Lake had estimated levels of 7.2 to 26 ppm (NED, 1992a). The average of the mean nickel concentrations for all other NED projects was 23 ppm. It should be noted that pollution classifications of these sediments are based on their overall condition and not just their nickel content.

In Barre Falls Dam sediments, nickel concentrations were estimated at 4.8 to 14 with a mean of 9.4 ppm. These levels meet Massachusetts DEQE standards for unpolluted sediments, are below the ER-M, essentially meet the ER-L, and are within the range measured at other NED projects. Both samples were in the range for unpolluted sediments according to the Great Lakes Sediment Guidelines. On the whole, nickel levels in sediments at Barre Falls Dam are typical of naturally occurring conditions and not a cause for concern. The absence of detectable nickel in the waters of Barre Falls Dam is a further indication that nickel is not a concern at this project.

(8) Selenium. Table 18 in Appendix B summarizes standards and data for selenium.

Selenium constitutes about 0.9 ppm of the earth's crust. It occurs in nature usually in the sulfide ores of metals. The forms of selenium in soil depend on pH and redox. At equilibrium, most soil selenium should be in the elemental form. In areas of acid rain or neutral soils, the amount of biologically available selenium readily declines. In trace amounts, selenium appears to be essential for the nutrition of animals, including man, although very little is known about the mechanism of its action (HSDB, 1993).

Selenium levels were measured at other NED projects including Thomaston Dam in Connecticut (NED, 1992b), Hop Brook Lake in Connecticut (NED, 1993c), and Otter Brook Lake in New Hampshire (NED, 1992a); however, levels were below detection limits. Two of three sediment samples from West Thompson Lake,

in Connecticut, had selenium levels that were above MDLs but below PQLs which ranged from 0.29 to 0.90 ppm (NED, 1993a).

According to the EPA, the acute freshwater aquatic life criteria is 0.020 ppm and the chronic freshwater aquatic life criteria is about 0.0051 ppm. There were no available Great Lakes Sediment Guidelines or State of Washington Guidelines for selenium. Also, there were no ER- L, ER-M or AET concentrations available for selenium.

At Barre Falls Dam, selenium concentrations were estimated at a range of 0.58 to 1.5 ppm with a mean of 1.04 ppm. These levels appear to be within the range of naturally occurring background levels and are not a concern at this project.

(9) Thallium. Table 19 in Appendix B summarizes standards and data for Thallium.

Pure Thallium is a bluish-white, soft, inelastic, heavy metal which oxidizes readily in air to thallium oxide. Thallium occurs in the Earth's crust to the extent of 0.6 ppm, mainly as a minor constituent in iron, copper, sulfide, and selenide ores. Thallium compounds are toxic to humans and other forms of life (HSDB, 1993).

Thallium salts are used as poisons for rats and other rodents, and as ant bait. It is a cumulative poison, four times as toxic as arsenous oxide, and it effects the sympathetic nervous system, causes muscular pains, endocrine disturbances, and loss of hair (McGraw-Hill).

Thallium salts are generally highly soluble in water and consequently any industrial discharges of this element are not likely to form precipitates as carbonates, hydroxides, or other common compounds.

Other NED projects where Thallium levels in sediments have been measured include Otter Brook Lake in New Hampshire which had less than 0.005 ppm (NED, 1992a), and Thomaston Dam in Connecticut which had less than 0.5 ppm (NED, 1992b).

Available EPA guidelines for acute freshwater aquatic life were 1.4 ppm, and chronic freshwater aquatic life criteria was 0.04 ppm. There were no available Great Lakes sediment guidelines for thallium.

With a maximum of less than 0.51 ppm, thallium levels at Barre Falls Dam are within the range of naturally occurring conditions, and not a concern at this project.

(10) Zinc. Table 20 in Appendix B summarizes standards and data for zinc.

Average concentration of zinc in the earth's crustal rocks is given as 50 to 200 ppm (McGraw-Hill). Although it occurs abundantly in rocks and ores, zinc carbonate, oxide, and sulfide are insoluble and zinc is normally found only in low concentrations in natural waters. Kesler-Arnold and O'Hearn (1990) found background levels in Lower Michigan soils had a range from less than 2.5 to 150 ppm with a mean of 35 ppm. Miller and McFee (1983) examined surficial soil samples from 5 areas of industrialized north-western Indiana; zinc levels ranged from 2,977 in urban soils to 476 ppm in rural soils. At a depth of 30 to 36 centimeters, all soil samples had 8 to 27 ppm zinc.

Neither EPA nor MADEP have established criteria for zinc in sediment. Guidelines for the Pollutional Classification of Great Lakes Harbor Sediments considered zinc levels less than 90 ppm as nonpolluted, 90-200 ppm as moderately polluted, and greater than 200 ppm as heavily polluted. The Massachusetts Dredging Handbook gives Type I, II, and III classifications for disposal of dredged material; for zinc, type I, II, III limits are <200, 200 to 400, and >400 ppm, respectively (Barr, 1987). The State of Washington set sediment quality standards for zinc of 410 ppm and sediment cleanup standards of 960 ppm (Ginn and Pastorok, 1992). Assuming a TOC of 8.9 percent at station BF02 and 3.4 percent at station BF10, sediment quality standards become 36.49 and 13.94, and cleanup standards become 85.44 and 32.64 for BF02 and BF10 respectively.

Long and Morgan (1990) reported an ER-L of 120, AET of 260, and an ER-M of 270 ppm with a high degree of confidence in the ER-L and ER-M.

Zinc levels from Gulf of Maine harbor sediments had a mean of 134 and a mean plus 2 standard deviations of 436 ppm for 598 samples. For 601 samples from dredged harbors from Cape Cod to Western Connecticut, the mean zinc levels was 283 and the mean plus 2 standard deviations was 1,010 ppm (NED, 1980a). An analysis of zinc in the sediments from 16 lakes in Massachusetts found a mean of 279 and a range of 80 to 843 ppm (Fratoni et al, 1982). The USGS measured 23 to 27 ppm zinc in sediments in the Merrimack River at Nashua, New Hampshire in 1975 (USGS, 1975).

Median zinc levels found in sediments in the 1975 Massachusetts Toxic Element Survey (Isaac and Delaney, 1975) ranged from 480 mg/Kg in the heavily polluted Blackstone River, to 57 mg/Kg in the moderately polluted North River, to 47 mg/Kg in the lightly polluted Quinsigamond River, to 16 mg/Kg in the clean South River. Maximum zinc levels in this study were 4,000, 985, 92, and 17 mg/Kg, respectively, from heavily polluted to clean. Lake Quinsigamond, which was considered clean, had sediments with a median of 410 mg/Kg and a maximum of 730 mg/Kg of zinc. That clean Lake Quinsigamond had sediments with zinc levels in the range of slightly polluted to heavily polluted

river sediments is not surprising since lake sediments seem to be more likely to trap and retain metals. Also, it should be remembered that these rivers were classified as polluted based on their general condition and not necessarily their zinc contents.

Highly polluted Ashtabula River sediments had 157 to 604 ppm (Leonard, 1986), and polluted Oxoboxo River sediments had 230 to 3,000 ppm (NED, 1980b). It should be noted, however, that these river sediments were not necessarily polluted with zinc.

Zinc was detected in sediments at a number of other NED projects. Three samples of possibly-contaminated sediments from West Thompson Lake, in Connecticut, had 83 to 1,200 ppm (NED, 1993a). At Thomaston Dam, in Connecticut, 140 to 280 ppm were found in lightly contaminated sediment samples from 2 stations (NED, 1992b). Hop Brook Lake, in Connecticut, also has lightly contaminated sediments; zinc analyses of two sediments found 33 to 280 ppm (NED, 1993c). A New Hampshire project with clean sediments, Otter Brook Lake had 29 to 85 ppm (NED, 1992a). The average of the mean zinc concentrations for all other NED projects was 243 ppm. It should be noted that pollution classifications of these sediments are based on their overall condition and not just their zinc content.

In Barre Falls sediments, concentrations ranged from 29 ppm at station BF10 to 63 ppm at station BF02. Both stations were below the ER-L, ER-M and AET. The levels at stations BF02 and BF10 meet the Massachusetts DEQE Type I sediment classification; they both have levels indicating nonpolluted sediments according to the Great Lakes Sediment Classification; they both meet State of Washington sediment cleanup standards; and they both are below the range measured at unpolluted Lake Quinsigamond and other NED projects. Sediments at station BF02 have consistently higher levels of heavy metals than those at station BF10. Station BF02 has higher concentrations of zinc in sediment than station BF10. On the whole, it appears that zinc concentrations at both stations are due to normal processes in the watershed. Low levels of zinc in the water samples further indicate that zinc concentrations are not a concern at this project.

g. Trace Metals in Water. Table 4 is a summary of trace metals analyses of water samples from Barre Falls Dam. Analyses were for total metals. Zinc was the only metal detected. Table 20 in Appendix B summarizes standards and data for zinc.

EPA set ambient water quality criteria for zinc based on hardness. Using the historical average hardness in the Ware River at Barre Falls Dam of 19 mg/l as CaCO_3 , the chronic criterion is 0.026 and the acute criterion is 0.029 mg/l. The chronic criterion is based on a 4-day average, and the acute criterion is based on a 1-hour average concentration. The measured zinc

TABLE 4

DETECTED CONCENTRATIONS BARRE FALLS DAM
TRACE METALS IN WATER

<u>Parameter</u>	<u>Station</u>	<u>Media</u>	<u>Concentration</u>	
			<u>Sample</u> (ppm)	<u>Blank</u> (ppm)
Zinc	BF02	Water	0.026	0.0083
Zinc	BF10	Water	0.015	

Notes:

J - Estimated value; analyte detected at less than the Practical Quantification Limit.

levels in the Ware River at Barre Fall Dam ranged from 0.015 to 0.026 mg/l. Although these are grab samples and cannot be directly compared to either a 1-hour or 4-day average, they do not exceed either the acute or chronic criteria. Furthermore, the zinc levels measured at Barre Falls Dam were for total zinc, while the criteria are for dissolved zinc. As the non-dissolved fraction is less harmful than the dissolved, it can safely be concluded that these zinc measurements do not indicate a cause for concern.

h. Volatile Organic Compounds. The only volatile organic compounds detected in water or sediments were acetone, methylene chloride, and 2-butanone. None of these were in concentrations high enough to be of concern. Table 5 summarizes volatile organic analyses at Barre Falls Dam.

(1) Acetone and Methylene Chloride. These compounds were reported in blank samples and are notorious laboratory artifacts. Consequently, the measurements of these compounds in sediment and water samples is likely due to sample contamination. Similar contamination problems have been reported for samples from other NED projects (NED, 1993a, 1993c).

(2) 2-Butanone. Table 21 in Appendix B summarizes standards and data for 2-butanone.

More commonly known as "methyl ethyl ketone," it is extensively used as a solvent in industrial processes. Additional uses include as a fragrance and flavoring agent in candy and perfumes, and a sterilizer for medical instruments (HSDB, 1992).

TABLE 5

DETECTED CONCENTRATIONS AT BARRE FALLS DAM
VOLATILE ORGANICS

<u>PARAMETER</u>	<u>STATION</u>	<u>MEDIA</u>	<u>CONCENTRATION</u>	
			<u>SAMPLE</u> (ppm)	<u>BLANK</u> (ppm)
Acetone	BF02	Sediment	0.460	J0.0039
Acetone	BF10	Sediment	0.098	
Methylene Chloride	BF02	Sediment	0.051	0.0091
Methylene Chloride	BF10	Sediment	0.038	
2-Butanone (MEK)	BF02	Sediment	0.180	<0.0016
2-Butanone (MEK)	BF10	Sediment	0.033	

Notes:

J- Estimated value; analyte detected at less than the Practical Quantification Limit.

Naturally occurring sources include volcanos, forest fires, biological degradation of organic matter, and foodstuffs (Graedel 1978, and Lande 1976). High atmospheric levels are formed as a component of photochemical smog; however, it is generally absent from ambient air (HSDB, 1992).

Methyl ethyl ketone (MEK) has little affinity for particulate matter and will evaporate quickly if spilled on soil. It is soluble in water, but will evaporate with an expected half life of 3 to 12 days. MEK biodegrades slowly and is not expected to bioconcentrate (HSDB, 1992). Little information is available on background concentrations in soils or sediments. No standards for MEK have been set for drinking water, air emissions, or to protect freshwater or marine organisms. The reportable release quantity under CERCLA is 5,000 pounds (IRIS 1993).

MEK measurements have been made at a few other NED projects; two of these projects--Thomaston Dam and Hop Brook Lake--have generally lightly contaminated conditions, while West Thompson Lake has possibly-contaminated sediments and Otter Brook Lake has clean sediments. In one of the two sediment samples examined from Thomaston Dam in Connecticut, the MEK concentration was too low to quantify but was estimated at 0.035 ppm; the other sample had less than the MDL of 0.287 ppm in the sample and

0.1 ppm in the method blank (NED, 1992b). Because the estimated level of 0.035 ppm in the sediment was below the detection limit in the blank, it is unlikely that any MEK was actually measured (Condiak, 1993). At Hop Brook Lake, also in Connecticut, analyses of two sediments found less than the detection limit of 0.089 ppm in one, and greater than the upper quantification limit of 472 ppm in the other. The sample with the higher MEK concentration was from the bottom of the lake which acted as a trap for fine-grained sediments and their attached contaminants. Three samples of possibly-contaminated sediments from West Thompson Lake (also in Connecticut) had 0.0098, 0.030, and 0.16 ppm. Measurements of clean sediments from Otter Brook Lake in New Hampshire did not find detectable concentrations.

At Barre Falls Dam, MEK the sediment concentration at station BF02 was 0.180 ppm, and at station BF10 was 0.033 ppm. The most likely source of MEK at station BF02 is the biological degradation of organic material. This MEK should be reduced over time by dissolution, volatilization, and biological degradation. It is unlikely that MEK is a problem at Barre Falls Dam.

i. Semi-Volatile Organic Compounds - Water. Three semi-volatile organic compounds detected in water samples from Barre Falls Dam; naphthalene, bis(2-ethylhexyl)phthalate and diethylphthalate. However, these compounds were also detected in blank samples at levels similar to those reported in water samples. Consequently, water measurements are assumed to be laboratory artifacts. Table 6 shows the detected concentrations of semi-volatile organic compounds at Barre Falls Dam.

j. Semi-Volatile Organic Compounds - Sediment. A number of semi-volatile organic compounds were detected in sediment samples from Barre Falls Dam. Many of these were also detected in the blank samples or were found at levels very close to the laboratory detection limit. None were found in harmful concentrations. Most of the detected compounds were either polynuclear aromatic hydrocarbons (PAHs) or phthalate esters. PAHs are ubiquitous products of incomplete combustion, and phthalate esters are plasticizers. Compounds reported in concentrations greater than MDLs in sediment are discussed in the following sections. Compounds are grouped together by class.

(1) Poly nuclear aromatic compounds.

(a) Benzo(a)anthracene. Table 22 in Appendix B summarizes standards and data for benzo(a)anthracene.

This PAH, also known as "benz(a)anthracene," is widespread in the environment due to its release as an incomplete combustion product of organic matter. It strongly binds to sediments and is rapidly removed from the water column by adsorption.

TABLE 6

DETECTED CONCENTRATIONS AT BARRE FALLS DAM
SEMI-VOLATILE ORGANICS

<u>PARAMETER</u>	<u>STATION</u>	<u>MEDIA</u>	<u>CONCENTRATION</u>	
			<u>SAMPLE</u>	<u>BLANK</u>
<u>PAHS</u>				
Benzo(a)anthracene	BF02	Soil	J 0.065	<0.0062
Benzo(a)anthracene	BF10	Soil	B 0.081	
Chrysene	BF02	Soil	J 0.053	<0.0062
Chrysene	BF10	Soil	< 0.081	
Fluoranthene	BF02	Soil	J 0.12	<0.0077
Fluoranthene	BF10	Soil	< 0.10	
Naphthalene	BF02	Water	JB0.00014	J0.00012
Naphthalene	BF10	Water	< 0.000074	
Naphthalene	BF02	Soil	B 0.10	J0.0096
Naphthalene	BF10	Soil	B 0.18	
Phenanthrene	BF02	Soil	J 0.11	<0.0062
Phenanthrene	BF10	Soil	J 0.12	
Pyrene	BF02	Soil	J 0.10	0.0067
Pyrene	BF10	Soil	< 0.087	
<u>Phthalate Esters</u>				
Bis(2ethylhexyl)phthalate	BF02	Water	< 0.00071	J0.00082
Bis(2ethylhexyl)phthalate	BF10	Water	< 0.00067	
Bis(2ethylhexyl)phthalate	BF02	Soil	J 0.38	<0.030
Bis(2ethylhexyl)phthalate	BF10	Soil	< 0.39	
Butylbenzylphthalate	BF02	Soil	J 0.15	<0.019
Butylbenzylphthalate	BF10	Soil	< 0.24	
Diethylphthalate	BF02	Water	B 0.00058	0.00067
Diethylphthalate	BF10	Water	J 0.00027	
Diethylphthalate	BF02	Soil	B 0.38	0.053
Diethylphthalate	BF10	Soil	B 1.1	
Di-n-butylphthalate	BF02	Soil	B 1.7	1.1
Di-n-butylphthalate	BF10	Soil	B 20	

TABLE 6
(Continued)

DETECTED CONCENTRATIONS AT BARRE FALLS DAM
SEMI-VOLATILE ORGANICS

Miscellaneous

Isophorone	BF02	Soil	J 0.27	<0.015
Isophorone	BF10	Soil	< 0.20	

Notes:

J - Estimated value; analyte detected at less than the Practical Quantification Limit.

B - Analyte detected in blank.

It bioconcentrates in aquatic organisms and degrades slowly when attacked by microorganisms acclimated to PAHs (HSDB, 1992).

Criteria have not been established for benzo(a)anthracene in drinking water; however, a maximum contaminant level goal of 0.0002 mg/L has been proposed. Criteria have not been established to protect freshwater aquatic life. The closest to an aquatic criterion is an LEC for marine organisms for acute conditions of 0.3 ppm.

No criteria have been established for benzo(a)anthracene in sediments. Long and Morgan (1990) report an ER-L of 0.23, an ER-M of 1.6, and an overall AET of 0.55 ppm with a low degree of confidence in the ER-L and a moderate degree of confidence in the ER-M.

Neither EPA nor CTDEP have established criteria for benzo(a)anthracene in sediment. The State of Washington set sediment quality standards of 110 ppm and sediment cleanup standards of 270 ppm benzo(a)anthracene (Ginn and Pastorok, 1992). Assuming a sediment TOC concentration of 8.9 percent at station BF02 and 3.4 percent at station BF10, the sediment quality standards become 9.8 and 3.7, and cleanup standards become 24 and 9.2 ppm for BF02 and BF10, respectively.

Benzo(a)anthracene was measured in soil and sediment at a few sites in North America. Sampling of two remote Adirondack Lakes found 0.078 to 0.36 ppm in surficial sediments (Tan and Heit). On the other hand, soils near traffic highways had 1.5 ppm and soil contaminated with coal-tar pitch had 2.5 ppm (IARC). Sampling of New England area sediments found 0.33 ppm in Buzzards Bay 0.15 miles from shore and 0.041 ppm 1.3 miles from shore; samples from the Atlantic Ocean shelf had 0.0036 to 0.0061 ppm (Santodonato).

Benzo(a)anthracene was detected in sediments at a few other NED projects. Three samples of possibly-contaminated sediments from West Thompson Lake, in Connecticut, had 0.46 to 1.4 ppm (NED, 1993a). At Thomaston Dam, in Connecticut, 0.68 to 1.6 ppm were found in lightly contaminated sediment samples from 2 stations (NED, 1992b). Hop Brook Lake, in Connecticut, also has lightly contaminated sediments; benzo(a)anthracene analyses of two sediments found 0.15 to 0.42 ppm (NED, 1993c). A New Hampshire project with clean sediments, Otter Brook Lake had 0.18 ppm at one station and an estimated 0.028 ppm at the second (NED, 1992a). The average of the mean benzo(a)anthracene concentrations for all other NED projects was 0.62 ppm. It should be noted that pollution classifications of these sediments are based on their overall condition and not just their benzo(a)anthracene content.

Sediment benzo(a)anthracene levels at Barre Falls Dam were reported as less than quantifiable but around 0.065 ppm at station BF02, and less than the detection limit of 0.081 ppm at station BF10. These levels are below the ER- M, ER-M, and AET. The level at both stations BF02 and BF10 is within the range for the concentrations found in clean Otter Brook Lake sediments and below the range found in lightly contaminated sediments at Thomaston Dam. The absence of detectable levels in the waters of Barre Falls Dam is a further indication that benzo(a)anthracene is not a concern at this project.

(b) Chrysene. Table 23 in appendix B summarizes standards and data for chrysene.

An ubiquitous product of incomplete combustion including forest fires and internal combustion engines, this PAH strongly binds to particulates. Consequently, it is quickly removed from water by adsorption and has little mobility in soils. It is biodegradable by acclimated micro-organisms, but will bioaccumulate in some higher organisms.

No water quality standards for chrysene have been established for drinking water, freshwater, or sediments; although, a MCL of 0.0002 mg/L has been proposed. Data are not available for lowest effects concentration (LEC) in freshwater, but LEC data for acute conditions in marine water are 0.3 mg/L (IRIS, 1992). Long and Morgan (1990) report an ER-L of 0.40, an ER-M of 2.8, and an overall AET of 0.90 ppm with a moderate degree of confidence in the ER-L and ER-M.

Neither EPA nor CTDEP have established criteria for chrysene in sediment. The State of Washington set sediment quality standards of 110 ppm and sediment cleanup standards of 460 ppm chrysene (Ginn and Pastorok, 1992). Assuming a sediment TOC concentration of 8.9 percent at station BF02 and 3.4 percent at station BF10, the sediment quality standards become 9.8 and 3.7, and cleanup standards become 41 and 16 ppm for BF02 and BF10, respectively.

Analyses of sediments in unpolluted areas found levels up to 1.5 ppm. Measurements of surficial sediments in remote Adirondack lakes found 0.19 to 0.89 ppm (Tan and Heit). Verschueren reported 0.023 ppm in sediment from Wilderness Lake, Ontario. Sampling of 7 stations in the Australian Great Barrier Reef found <0.0006 to 1.5 ppm (Prah1 and Carpenter).

Only two studies of chrysene in New England sediments were located. Sims and Overcash reported that estuarine sediment from Buzzards Bay had 0.24 ppm 0.5 miles from1986Xshore, and 0.04 ppm at a distance of 1.3 miles from shore. Hites et al sampled one station in the Charles River basin and found 21 ppm chrysene.

Chrysene was detected in sediments at a few other NED projects. Three samples of possibly-contaminated sediments from West Thompson Lake, in Connecticut, had 0.71 to 2.0 ppm (NED, 1993a). At Thomaston Dam, in Connecticut, 0.88 to 1.9 ppm were found in lightly contaminated sediment samples from 2 stations (NED, 1992b). Hop Brook Lake, in Connecticut, also has lightly contaminated sediments; chrysene analyses of two sediments found 0.22 to 0.63 ppm (NED, 1993c). A New Hampshire project with clean sediments, Otter Brook Lake had 0.22 ppm at one station and an estimated 0.03 ppm at a second (NED, 1992a). The average of the mean chrysene concentrations for all other NED projects was 1.15 ppm. It should be noted that pollution classifications of these sediments are based on their overall condition and not just their chrysene content.

Sediment chrysene levels at Barre Falls Dam were reported as less than the practical quantification limit of 0.053 ppm at station BF02, and less than the detection limit of 0.081 ppm at station BF10. These levels are below the ER-M, ER-L and AET. The chrysene levels at both BF02 and BF10 are within the range found in clean Otter Brook Lake sediments. The two stations also show levels below the range found for lightly contaminated sediments in Thomaston Dam. The absence of detectable levels in the waters of Barre Falls Dam is a further indication that chrysene is not a concern at this project.

(c) Fluoranthene. Table 24 in Appendix B summarizes standards and data for fluoranthene.

This PAH is widespread in the environment because it is a universal product of incomplete combustion including natural sources such as forest fires. It absorbs strongly to particles and will be quickly removed from the water column and have limited mobility in soils. It bioconcentrates in aquatic organisms, but will biodegrade in the presence of acclimated microorganisms (HSDB, 1992). A derivative of coal tar, it is considered insoluble in water (Merck).

No drinking water standards have been established for fluoranthene. For toxicity protection, a level of 0.042 ppm was estimated for ingestion of water and organisms living in that water, while 0.054 ppm was estimated for ingestion of organisms alone. To protect freshwater aquatic life, an acute criterion of 3.98 ppm is given (IRIS, 1992). No criteria have been developed for fluoranthene in sediments. Long and Morgan (1990) report an ER-L of 0.60, an ER-M of 3.6, and an overall AET of 1.0 ppm with a high degree of confidence in the ER-L and ER-M.

Neither EPA nor CTDEP have established criteria for fluoranthene in sediment. The State of Washington set sediment quality standards of 160 ppm and sediment cleanup standards of 1200 ppm for fluoranthene (Ginn and Pastorok, 1992).

Assuming a sediment TOC concentration of 8.9 percent at station BF02 and 3.4 percent at station BF10, the sediment quality standards become 14 and 5.4 and cleanup standards become 107 and 41 ppm for BF02 and BF10, respectively.

Fluoranthene has been measured in soil or sediment at a number of sites around the world. Relatively pristine Dungeness Bay, Washington sediments had concentrations of 0.0075 to 0.024 for (MacLeod), while remote areas of South America, Africa, and the Pacific atolls had 0 to 0.0098 ppm (Hites et al). In the New England area, Buzzards Bay sediments had 0.00011 to 0.00079 ppm (Santodonato). Samples taken from the mouth of the Charles River out into Massachusetts Bay decreased from 13 to 0.019 ppm (Eadie).

Vogt, et al. (1987) investigated PAH levels around metal smelters in Norway. They found average fluoranthene concentrations of 0.573 ppm in polluted soils, 0.0223 ppm in nonpolluted soils, and 0.0832 ppm in bog soils. The bog soils were not directly affected by known sources of contamination, but had consistently higher levels of PAHs than nonpolluted soils. Vogt did not determine whether the high organic content of the soils accumulated PAHs from atmospheric inputs, or if PAHs were formed in the bog environment.

Fluoranthene was detected in sediments at a few other NED projects. Three samples of possibly-contaminated sediments from West Thompson Lake, in Connecticut, had 0.87 to 3.2 ppm (NED, 1993a). At Thomaston Dam, in Connecticut, 1.8 to 3.0 ppm were found in lightly contaminated sediment samples from 2 stations (NED, 1992b). Hop Brook Lake, in Connecticut, also has lightly contaminated sediments; fluoranthene analyses of two sediments found 0.24 to 0.99 ppm (NED, 1993c). A New Hampshire project with clean sediments, Otter Brook Lake had a less than detectable concentration estimated at 0.07 ppm at one station and 0.50 ppm at a second (NED, 1992a). The average of the mean fluoranthene concentrations for all other NED projects was 1.8 ppm. It should be noted that pollution classifications of these sediments are based on their overall condition and not just their fluoranthene content.

Sediment fluoranthene concentrations at Barre Falls Dam were below the practical quantification limit of 0.12 ppm at station BF02, and less than the detection limit of 0.10 ppm at station BF10. These concentrations are orders of magnitude below Washington State sediment standards. These levels are also below the ER-L, ER-M and AET. The levels at station BF02 and BF10 are within the range found in clean Otter Brook Lake sediments, and are below the range of lightly contaminated Thomaston Dam sediments. The absence of detectable levels in the waters of Barre Falls Dam is a further indication that fluoranthene is not a concern at this project.

(d) Naphthalene. Table 25 in Appendix B summarizes standards and data for naphthalene.

As reported in McKee and Wolf, this PAH is a white solid with the odor of moth balls, and the most abundant single constituent of coal tar. It is soluble in water at 20 degrees centigrade to the extent of about 30 mg/L. The use of naphthalene in organic synthesis and dye manufacture is extensive, and hence it may occur in wastes from refineries, coal-tar plants, textile mills, and chemical industries.

Naphthalene enters the atmosphere primarily through emissions from coal, oil, and gasoline burning operations including internal combustion engines. Natural sources include forest fires (HSDB, 1992).

Naphthalene rapidly photodegrades in the atmosphere, and is removed from water by volatilization, photodegradation, adsorption, and biodegradation. If released to soil or sediments, it moderately adsorbs to particulate matter, but may have some mobility in ground water. Naphthalene biodegrades in soils and sediments under aerobic conditions. Some bioconcentration can occur, but depuration and metabolism prevent this from being more than a short-term problem (HSDB, 1992).

No drinking water standards or freshwater aquatic life criteria have been established for naphthalene. Lowest observed effects concentrations for freshwater aquatic organisms are 2.3 ppm for acute exposure and 0.62 ppm for chronic exposure (IRIS, 1992).

Long and Morgan (1990) reported an ER-L of 0.34, AET of 0.50, and an ER-M of 2.1 ppm with a moderate degree of confidence in the ER-L and a high degree of confidence in the ER-M.

Neither EPA nor CTDEP have established criteria for naphthalene in sediment. The State of Washington set sediment quality standards of 99 ppm and sediment cleanup standards of 170 ppm for naphthalene (Ginn and Pastorok, 1992). Assuming a sediment TOC concentration of 8.9 percent at station BF02 and 3.4 percent at station BF10, the sediment quality standards become 8.8 and 3.4, and cleanup standards become 15 and 5.8 ppm for BF02 and BF10, respectively.

A number of researchers have measured naphthalene concentrations in soils or sediments. Larsen, et al (1983) detected naphthalene in one of thirty sediment samples from Casco Bay, Maine, at a concentration of 0.113 ppm. Teal, et al., (1978) measured naphthalene concentrations in Buzzards Bay, Massachusetts, following an October 1974 oil spill. In surficial

sediments (0 to 6 cm), they reported 9.2 ppm in October 1974, 0.63 ppm in May 1975, and 0.22 ppm in June 1977.

Vogt, et al. (1987) investigated PAH levels around metal smelters in Norway. They found average naphthalene concentrations of 0.0483 ppm in polluted soils, 0.0463 ppm in nonpolluted soils, and 0.0577 ppm in bog soils. The bog soils were not directly affected by known sources of contamination, but had consistently higher levels of PAHs than nonpolluted soils. Vogt did not determine whether the high organic content of the soils accumulated PAHs from atmospheric inputs, or if PAHs were formed in the bog environment.

Naphthalene was detected in sediments at a few other NED projects. Three samples of possibly-contaminated sediments from West Thompson Lake, in Connecticut, had 0.13 to 0.32 ppm; however, it was also detected in the blank at an estimated concentration of 0.12 ppm (NED, 1993a). At Thomaston Dam, in Connecticut, estimated levels of 0.03 to 0.052 ppm were found in lightly contaminated sediment samples from 2 stations (NED, 1992b). Hop Brook Lake, in Connecticut, also has lightly contaminated sediments; naphthalene analyses of two sediments found estimated levels of 0.014 to 0.030 ppm (NED, 1993c). A New Hampshire project with clean sediments, Otter Brook Lake had less than the MDL of 0.051 ppm one station and less than the PQL of 0.014 ppm at a second (NED, 1992a). The average of the mean naphthalene concentrations for all other NED projects was 0.072 ppm. It should be noted that pollution classifications of these sediments are based on their overall condition and not just their naphthalene content.

Sediment naphthalene concentrations at Barre Falls Dam were reported as 0.10 ppm at station BF02 and 0.18 at BF10. These levels are below the ER-L, ER-M and AET; orders of magnitude below Washington State sediment quality standards; and within the range found at other NED projects. Reported sediment naphthalene levels are also close to the estimated 0.12 ppm in the blank; this indicates the sediment samples may have been contaminated and actual naphthalene levels are lower than reported. Similarly, the reported level in the water at station BF02 was less than that reported in the blank, indicating that detected levels at this project may be due to sample contamination. Overall, naphthalene levels are not a concern at this project.

(e) Phenanthrene. Table 26 in Appendix B summarizes standards and data for phenanthrene.

This PAH is produced by incomplete combustion; consequently, it is ubiquitous in the environment. It binds strongly to soil particles and is quickly removed from water by adsorption. Phenanthrene is biodegradable in soils (HSDB, 1992).

No criteria for drinking water or sediments have been established. Freshwater aquatic life criteria are 30 ug/L for acute conditions and 6.3 ug/L for chronic (IRIS, 1992).

Long and Morgan (1990) report an ER-L of 0.225, an ER-M of 1.38, and an overall AET of 0.26 ppm with a moderate degree of confidence in the ER-L and ER-M for phenanthrene.

Neither EPA nor CTDEP have established criteria for phenanthrene in sediment. The State of Washington set sediment quality standards of 100 ppm and sediment cleanup standards of 480 ppm for phenanthrene (Ginn and Pastorok, 1992). Assuming a sediment TOC concentration of 8.9 percent at station BF02 and 3.4 percent at station BF10, the sediment quality standards become 8.9 and 3.4, and cleanup standards become 43 and 16 ppm for BF02 and BF10, respectively.

Phenanthrene has been found in surficial sediment in New York Lakes ranging from 0.015 to 0.32 ppm (Tan & Heit). Sediment samples from Boston Harbor had up to 3 ppm combined anthracene plus phenanthrene (Windsor & Hites). Measurements of New England area soil samples showed levels of combined anthracene plus phenanthrene of 0.063 ppm in Maine and 0.12 in Stoneham, Massachusetts urban soils. Measurements of combined anthracene plus phenanthrene in soils from around the world found 0.001 to 100 ppm in Nova Scotia, 0.0048 to 0.03 ppm in Wyoming, 0.0025 to 0.067 ppm in Alaska, 0.0036 ppm in Hawaii, and 0.0003 ppm in Samoa (Hites et al, 1980).

Vogt, et al. (1987) investigated PAH levels around metal smelters in Norway. They found average phenanthrene concentrations of 0.353 ppm in polluted soils, 0.030 ppm in nonpolluted soils, and 0.0777 ppm in bog soils. The bog soils were not directly affected by known sources of contamination, but had consistently higher levels of PAHs than nonpolluted soils. Vogt did not determine whether the high organic content of the soils accumulated PAHs from atmospheric inputs, or if PAHs were formed in the bog environment.

Phenanthrene was detected in sediments at a few other NED projects. Three samples of possibly-contaminated sediments from West Thompson Lake, in Connecticut, had 0.62 to 1.5 ppm (NED, 1993a). At Thomaston Dam, in Connecticut, 1.2 to 1.9 ppm were found in lightly contaminated sediment samples from 2 stations (NED, 1992b). Hop Brook Lake, in Connecticut, also has lightly contaminated sediments; phenanthrene analyses of two sediments found 0.30 to 0.59 ppm (NED, 1993c). A New Hampshire project with clean sediments, Otter Brook Lake had a less than quantifiable concentration estimated at 0.056 ppm at one station and 0.39 ppm at a second (NED, 1992a). The average of the mean phenanthrene concentrations for all other NED projects was 1.4 ppm. It should be noted that pollution classifications of these

sediments are based on their overall condition and not just their phenanthrene content.

Sediment phenanthrene concentrations at Barre Falls Dam were below the practical quantification limit of 0.12 ppm at both stations. These phenanthrene levels are below the ER-L of 0.225, the ER-M of 1.38, and the AET of 0.26. Barre Falls Dam sediment phenanthrene levels are above background levels reported for many parts of the world, and in the range of Norwegian soils contaminated with total PAHs. On the other hand, they are orders of magnitude below Washington State sediment standards, in the range found in clean sediments from New York Lakes and NED's Otter Brook Lake project in New Hampshire, and below those found at NED's Thomaston Dam in Connecticut. On the whole, phenanthrene levels are too close to the method detection limit to accurately evaluate, but appear to be within the range of background conditions, and due to natural processes in the watershed. The absence of detectable levels in the waters of Barre Falls Dam is a further indication that phenanthrene is not a concern at this project.

(f) Pyrene. Table 27 in Appendix B summarizes standards and data for pyrene.

This PAH is a product of incomplete combustion and ubiquitous in the environment. It binds strongly to sediments and is quickly removed from the water column by adsorption. It bioaccumulates slightly in higher organisms, and is biodegraded by microorganisms acclimated to PAHs (HSDB, 1992). Also known as "benzophenanthrene," this derivative of coal tar is considered insoluble in water (Merck).

No criteria have been established for pyrene for drinking water or freshwater aquatic life. The LEC for marine organisms for acute conditions was 0.3 ppm.

Long and Morgan (1990) report an ER-L of 0.35, an ER-M of 2.2, and an overall AET of 1.0 ppm with a moderate degree of confidence in the ER-L and ER-M.

Neither EPA nor CTDEP have established criteria for pyrene in sediment. The State of Washington set sediment quality standards of 1000 ppm and sediment cleanup standards of 1400 ppm for phenanthrene (Ginn and Pastorok, 1992). Assuming a sediment TOC concentration of 8.9 percent at station BF02 and 3.4 percent at station BF10, the sediment quality standards become 89 and 34, and cleanup standards become 120 and 48 ppm for BF02 and BF10, respectively.

Pyrene was measured in soil or sediment at a number of sites in North America. Wilderness Lake in Ontario had 0.023 ppm in sediments (Verschuere), while remote Woods Lake in

the Adirondacks had 0.016 to 0.93 ppm in surficial sediments (Tan and Heit). Buzzards Bay sediments had 0.12 to 0.96 ppm (Santodonato). Highest reported New England area sediments concentrations were in the Charles River at Boston where up to 13 ppm were measured (Hites et al).

Vogt, et al. (1987) investigated PAH levels around metal smelters in Norway. They found average pyrene concentrations of 0.459 ppm in polluted soils, 0.0197 ppm in nonpolluted soils, and 0.0897 ppm in bog soils. The bog soils were not directly affected by known sources of contamination, but had consistently higher levels of PAHs than nonpolluted soils. Vogt did not determine whether the high organic content of the soils accumulated PAHs from atmospheric inputs, or if PAHs were formed in the bog environment.

Pyrene was detected in sediments at a few other NED projects. Three samples of possibly-contaminated sediments from West Thompson Lake, in Connecticut, had 1.3 to 3.4 ppm (NED, 1993a). At Thomaston Dam, in Connecticut, 2.4 to 4.8 ppm were found in lightly contaminated sediment samples from 2 stations (NED, 1992b). Hop Brook Lake, in Connecticut, also has lightly contaminated sediments; pyrene analyses of two sediments found 0.64 to 2.0 ppm (NED, 1993c). A New Hampshire project with clean sediments, Otter Brook Lake had a less than quantifiable concentration estimated at 0.094 ppm at one station and 0.58 ppm at a second (NED, 1992a). The average of the mean pyrene concentrations for all other NED projects was 1.9 ppm. It should be noted that pollution classifications of these sediments are based on their overall condition and not just their pyrene content.

Sediment pyrene concentrations at Barre Falls Dam were less than the 0.087 ppm MDL at station BF10, and detected but below the PQL of 0.10 ppm at station BF02. These pyrene levels are below the ER-L of 0.35 ppm, below the ER-M of 2.2 ppm and below the AET of 1.0 ppm. Levels at station BF10 are below unpolluted sediment concentrations in Norwegian soils; below concentrations in Wilderness Lake, Ontario; below Charles River in Boston, and in the range of both Woods Lake in Adirondacks and Buzzards Bay. Pyrene concentrations at station BF02 were below the concentrations for polluted soils but above the concentrations for unpolluted sediments in Norwegian soils; above the concentrations found at Wilderness Lake, Ontario; below the concentrations found in Charles River in Boston; and within the range of levels found in both Woods Lake in the Adirondacks and Buzzards Bay. On the other hand, Barre Falls Dam sediment pyrene concentrations are orders of magnitude below Washington State sediment standards or the maximum level measured in the polluted Charles River in Boston. Levels at Barre Falls Dam are also below those measured at NED's Thomaston Dam project in Connecticut. On the whole, pyrene levels at Barre Falls Dam appear to be within the range of natural background concentrations. The

absence of detectable levels in water is a further indication that pyrene is not a concern at this project.

(2) Phthalate Esters.

(a) Bis(2-ethylhexyl)phthalate. Table 28 in Appendix B summarizes standards and data for bis(2-ethylhexyl)-phthalate.

Also known as "di(2-ethylhexyl)phthalate" and "phthalic acid, bis(2-ethylhexyl) ester," it is a common plasticizer especially in the manufacture of PVC. It is released to the environment during the manufacture and incineration of these plastics, as well as leaching from plastic materials. It has an affinity for particles, is biodegradable, and bioconcentrates in higher organisms (HSDB, 1992). Bis(2-ethylhexyl) phthalate is also a common laboratory contaminant.

Criteria for bis(2-ethylhexyl)phthalate in drinking water have not been established; however, a maximum contaminant level goal of 4 ug/L has been proposed. Criteria to protect freshwater aquatic life have been set at 0.40 mg/L for acute conditions and 0.36 for chronic conditions (IRIS 1992).

Neither EPA nor CTDEP have established criteria for bis(2-ethylhexyl)phthalate in sediment. The State of Washington set sediment quality standards of 47 ppm and sediment cleanup standards of 78 ppm bis(2-ethylhexyl)phthalate (Ginn and Pastorok, 1992). Assuming a sediment TOC concentration of 8.9 percent at station BF02 and 3.4 percent at station BF10, the sediment quality standards become 4.2 and 1.6, and cleanup standards become 6.9 and 2.6 ppm for BF02 and BF10, respectively.

Sediment data for bis(2-ethylhexyl)phthalate is limited; however, a sampling of 9 coastal sites at Portland, Maine found levels above MDLs at all locations with a range of 0.06 to 7.8 ppm (Ray et al).

Bis(2-ethylhexyl)phthalate was detected in sediments at a few other NED projects. Three samples of possibly-contaminated sediments from West Thompson Lake, in Connecticut, had a mean of 1.4 and a maximum of 2.1 ppm (NED, 1993a). At Thomaston Dam, in Connecticut, 0.14 to 0.98 ppm were found in lightly contaminated sediment samples from 2 stations (NED, 1992b). Hop Brook Lake, in Connecticut, also has lightly contaminated sediments; bis(2-ethylhexyl)phthalate analyses of two sediments found 0.41 to 0.52 ppm (NED, 1993c). A New Hampshire project with clean sediments, Otter Brook Lake had 0.10 ppm at one station and a less than the MDL of 0.053 ppm at a second (NED, 1992a). The average of the mean bis(2-ethylhexyl)phthalate concentrations for all other NED projects was 0.62 ppm. It should be noted that pollution classifications of these sediments

are based on their overall condition and not just their bis(2-ethylhexyl)phthalate content.

Bis(2-ethylhexyl)phthalate was less than the practical quantification limit of 0.38 ppm in sediment from station BF02 and less than the 0.39 ppm detection limit in sediment from station BF10. These levels are low compared to State of Washington sediment standards, and below the mean measured at other NED projects. On the whole, levels of this compound are too close to the method detection limit to accurately evaluate, especially given its reputation as a notorious laboratory artifact. However, it appears that, in any case, levels at Barre Falls Dam are within the range of natural background conditions.

(b) Butylbenzylphthalate. Table 29 in Appendix B summarizes standards and data for butylbenzylphthalate.

Butylbenzylphthalate is a clear, oily, liquid with a slight odor. Prolonged contact with this substance causes some irritation to the skin and eyes. If absorbed it is a central nervous system depressant (HSDB, 1993).

Butylbenzylphthalate is used as a plasticizer for polyvinyl and cellulosic resins, primarily in poly vinyl chloride. Possible sources to the environment are from its manufacture, distribution, and poly vinyl chloride blending operations. Most butylbenzylphthalate releases will be to the soil and water and not to the air. Butylbenzylphthalate released to aquatic systems will absorb into sediments and biota, and will not volatilize significantly except under windy conditions or from shallow rivers. Butylbenzylphthalate is readily biodegraded in activated sludge, semi-continuous activated sludge, salt water, lake water and under anaerobic conditions (HSDB, 1993).

Butylbenzylphthalate was measured at other NED projects including Thomaston Dam, Hop Brook and West Thompson Lakes in Connecticut, and Otter Brook Lake in New Hampshire; however, it was not detected in sediments from any of these projects. Reported levels of butylbenzylphthalate in sediments at Barre Falls Dam were less than the MDL of 0.24 ppm at station BF10, and detected but less than the PQL of 0.15 ppm at station BF02. These levels are below the Washington State sediment cleanup and quality standards; however, they are too close to the method detection limit to evaluate accurately. On the whole, it appear that butylbenzylphthalate levels at Barre Falls Dam are within the range of natural background conditions.

(c) Diethylphthalate. Table 30 in Appendix B summarizes standards and data for diethylphthalate.

Also known as "ethyl phthalate" and "phthalic acid, diethyl ester," it is an insoluble, oily liquid (Merck). It has many uses including a solvent in manufacturing of varnishes, fixative for perfumes, and denaturing of alcohol; however, its primary use is as a plasticizer. As such, it is ubiquitous in the environment being released during the manufacture and incineration of plastics. It is also released from plastics directly. Plastic waste is the main source of diethyl phthalate into soil, water, and air (HSDB, 1992). Through volatilization and leaching phthalates are also common laboratory contaminants.

Diethylphthalate adsorbs moderately to particulates and has limited mobility in soil. It biodegrades readily and does not bioconcentrate because it is readily metabolized (HSDB, 1992).

Neither EPA nor CTDEP have established criteria for diethylphthalate in sediment. The State of Washington set sediment quality standards of 61 ppm for and sediment cleanup standards of 110 ppm diethylphthalate (Ginn and Pastorok, 1992). Assuming a sediment TOC concentration of 8.9 percent at station BF02 and 3.4 percent at station BF10, the sediment quality standards become 5.4 and 21, and cleanup standards become 9.8 and 3.7 ppm for BF02 and BF10, respectively.

Concentrations measured at other sites include 0.013 to 0.049 ppm in surficial sediments in Chesapeake Bay (Peterson and Freeman, 1982), 0.011 to 0.044 ppm in sediments from the Chester River in Maryland (Peterson and Freeman, 1984), 0.025 to 0.065 ppm in sediments from Lake Pontchartrain, Louisiana (McFall, et al 1985), and less than 0.002 to 0.009 ppm in sediments from San Luis Pass, Texas (Murray, et al 1981).

Diethylphthalate was detected in sediments at a few other NED projects. Three samples of possibly-contaminated sediments from West Thompson Lake, in Connecticut, had 0.19 to 1.4 ppm; however, the blank sample had 0.16 ppm (NED, 1993a). At Thomaston Dam, in Connecticut, 0.088 to 0.091 ppm were found in lightly contaminated sediment samples from 2 stations (NED, 1992b). Hop Brook Lake, in Connecticut, also has lightly contaminated sediments; diethylphthalate analyses of two sediments found 0.22 to 0.29 ppm (NED, 1993c). A New Hampshire project with clean sediments, Otter Brook Lake had a less than the MDL of 0.053 ppm at one station and 0.091 ppm at a second; however, 0.076 ppm were measured in the blank raising the possibility of sample contamination (NED, 1992a). The average of the mean diethylphthalate concentrations for all other NED projects was 0.26 ppm. It should be noted that pollution classifications of these sediments are based on their overall condition and not just their diethylphthalate content.

Diethylphthalate levels in sediments at Barre Falls Dam ranged from 1.1 ppm at station BF02 to 0.38 ppm at station BF10. These levels are fairly high compared to concentrations measured at other NED projects and background levels reported by others. However, they are very low compared to Washington State sediment standards. Furthermore, 0.053 ppm were measured in the blank raising the possibility of sample contamination. On the whole, it appears that diethylphthalate levels in sediments at Barre Falls Dam are on the high end of natural background conditions, but are not a concern at this project.

(d) Di-n-butylphthalate. Table 31 in Appendix B summarizes standards and data for Di-n-butylphthalate.

Also known as "dibutyl phthalate," "n-butyl phthalate," and "phthalic acid, dibutyl ester," it is an ubiquitous pollutant in the environment due to its widespread use as a plasticizer. It is released in vapor emissions during manufacturing and incineration of plastics, and from migration from plastics containing it. Di-n-butylphthalate absorbs moderately to sediments, is readily biodegradable, and does not bioconcentrate because it is readily metabolized (HSDB, 1992). An oily liquid, it is soluble in water at about 400 ppm (Merck).

Neither EPA nor CTDEP have established criteria for di-n-butylphthalate in sediment. The State of Washington set sediment quality standards of 220 ppm and sediment cleanup standards of 1700 ppm for di-n-butylphthalate (Ginn and Pastorok, 1992). Assuming a sediment TOC concentration of 8.9 percent at station BF02 and 3.4 percent at station BF10, the sediment quality standards become 20 and 7.5 and cleanup standards become 150 and 58 ppm for BF02 and BF10, respectively.

Di-n-butylphthalate was measured in soil and sediments at a number of locations in the United States. Surficial sediments in Chesapeake Bay had 27 and 89 ppb with the site closest to Baltimore Harbor having the higher concentration (Peterson and Freeman, 1982). Eight samples of Portland, Maine sediment had 40 to 280 ppb with a mean of 160 ppb (Ray et al, 1983). Giam found di-n-butylphthalate concentrations of 0 to 52.1 ppb, 13 ppb average in the Mississippi delta; 0 to 15.3 ppb, 7.6 ppb average in the Gulf coast; and 1.6 to 5.6 ppb, 3.4 ppb average in the open Gulf (Giam et al, 1978). Mayer reported 100 ppb in sediments in Black Bay of Lake Superior (Mayer et al, 1972). Lake Erie sediments from 18 locations from the Detroit River to Stony Point had 3-6 ppb, and Lake Huron at the Saginaw River had 290 ppb (Konasewich et al, 1978). Surficial sediment from the Delaware River estuary had 4.5 ppb (Hochreiter, 1982).

Di-n-butylphthalate was detected in sediments at a few other NED projects. Three samples of possibly-contaminated sediments from West Thompson Lake, in Connecticut, had 2.3 to

49 ppm; however, 1.4 ppm were measured in the blank raising the possibility of sample contamination (NED, 1993a). At Thomaston Dam, in Connecticut, 0.11 to 0.14 ppm were found in lightly contaminated sediment samples from 2 stations (NED, 1992b). Hop Brook Lake, in Connecticut, also has lightly contaminated sediments; di-n-butylphthalate analyses of two sediments found less than the MDL of 0.042 ppm at one station and 0.26 ppm at a second; however, 0.27 ppm were measured in the blank making it likely that sample contamination was the source of the measured level in the sediment (NED, 1993c). A New Hampshire project with clean sediments, Otter Brook Lake had a range of 0.14 to 0.26 ppm at two stations; however, 0.10 ppm were measured in the blank (NED, 1992a). The average of the mean di-n-butylphthalate concentrations for all other NED projects was 4.6 ppm. It should be noted that pollution classifications of these sediments are based on their overall condition and not just their di-n-butylphthalate content.

Measured levels of di-n-butylphthalate in sediments at Barre Falls Dam ranged from 1.7 ppm at station BF02 to 20 ppm at station BF10; however, 1.1 ppm were reported in the method blank. Di-n-butylphthalate is a common laboratory contaminant due to its widespread use as a plasticizer. Levels reported for Barre Falls Dam sediments are somewhat elevated compared to other NED projects and background concentrations reported by others. However, the finding of di-n-butylphthalate in the method blanks for Barre Falls Dam, and Otter Brook, Hop Brook, and West Thompson Lakes makes it highly likely that actual levels are lower. In any event, reported levels are well below Washington State sediment cleanup standards, and are not a concern at this project.

(3) Isophorone. Table 32 in Appendix B summarizes the standards and data for Isophorone.

Isophorone is a colorless to pale yellow liquid with a peppermint to camphor like odor, and is slightly soluble in water. An unsaturated cyclic ketone, it is used as a solvent for poly vinyl and nitri cellulose resins, in lacquers and finishes, and as a chemical intermediate as well as a variety of fats, oils, and gums. It is also used in pesticides and herbicides (HSDB, 1993).

Isophorone is mildly toxic by inhalation and moderately toxic by ingestion and skin contact. A skin and severe eye irritant, repeated or prolonged skin contact with the liquid may cause dermatitis because of its defatting action. It is a questionable carcinogen, based on available data. (HSDB, 1993).

If released to soil or water, isophorone is predicted to be removed partially by volatilization and partially by biodegradation (HSDB, 1993).

Potential exists for contamination of groundwater by leaching through soil. Isophorone is not expected to be absorbed significantly by solids or sediments in water, bioaccumulate significantly in aquatic organisms, photolyze, oxidize in water, or undergo chemical hydrolysis. If released to air, isophorone is expected to exist primarily in the vapor phase (HSDB, 1993).

According to the EPA the acute freshwater aquatic life criteria concentration is 117 ppm. There were no available concentrations for the chronic freshwater aquatic life criteria. There are questions as to whether or not isophorone was detected in aquatic life forms. Although believed to be small, EPA is unable to rate the threat of isophorone to aquatic life forms (U.S. EPA, 1986). Also, there were no available levels for biological sediment effects or the State of Washington sediment management standards.

Isophorone was not detected at other NED projects including Thomaston Dam, and West Thompson and Hop Brook Lakes in Connecticut; and Otter Brook Lake in New Hampshire.

Measured levels of isophorone in sediments at Barre Falls Dam ranged from less than the MDL of 0.20 ppm at station BF10, to less than the practical quantification limit of 0.27 ppm at station BF02. In as much as isophorone was only barely detected at one station and not detected at all at the other, and that it does not appear to be very toxic aquatic life, it seems unlikely sediment isophorone levels are a problem at this project.

8. SUMMARY

a. PCBs. No PCBs were found in water and only low levels were found in sediments. Measured PCB concentrations in Barre Falls Dam are typical of background concentrations. Such levels may be high enough to have effects on organisms, but are not toxic and are well below levels requiring cleanup or remediation.

b. Dioxins and Furans. No furans were found in sediments or water. No dioxins were found in water samples, and only low levels were found in sediments. Dioxin levels at Barre Falls Dam appear to be somewhat high for clean sediments, but are within the range of background conditions. Although the level of OCDD was somewhat above mean levels for uncontaminated soils, it is within the range observed for urban U.S. soils without an obvious source of contamination. Dioxin levels at Barre Falls Dam should have a priority for a repeat monitoring, but are not otherwise a concern.

c. Pesticides. No pesticides were detected in water samples, but DDD (a metabolite of DDT) and Endosulfan were found in sediment samples. Reported levels were on the high end of the

range of background conditions, probably because of agricultural activities in the watershed. However, concentrations were not so high as to indicate unusual or harmful conditions.

d. Metals in Soil. Most of the metals analyzed were detected in soils which is as would be expected. All metals except thallium were higher at station BF02 than BF10, due, most likely, to the higher TOC concentrations at station BF02. Metals in water tend to bind to particulate matter, especially organic matter, making the finding of higher metals levels at BF02 unsurprising. Metals levels at both stations were below levels expected to have significant effects on aquatic life.

e. Metals in Water. Metals analyses in water at Barre Falls Dam found generally low to below MDLs. No metals were found in levels which were a threat to humans or aquatic life at Barre Falls Dam. The only metal detected in the water sample was zinc. The levels found in these sample are not indicative of a threat to aquatic life at Barre Falls.

f. Volatile Organic Compounds. The only volatile organics detected in water or sediments were acetone, methylene chloride, and 2-butanone. None of these were in concentrations high enough to be of concern. Acetone and Methylene chloride are common laboratory artifacts, and both were detected in the blank; consequently, measured levels were assumed to be due to sample contamination.

Levels of 2-butanone, better known as methyl ethyl ketone (MEK), were above MDLs in both sediment samples. Its likely source is the biological degradation of organic material. This MEK should be reduced over time by dissolution and volatilization, and further biological degradation. There are no indications that MEK is a problem at this project.

g. Semi-Volatile Organic Compounds - Water. The only semi-volatile organic compounds detected in water samples from Barre Falls Dam were naphthalene, bis(2-ethylhexyl)phthalate, and diethylphthalate. These compounds were found in the method blank and are notorious laboratory artifacts; consequently, the detected levels were assumed to be due to sample contamination.

h. Semi-Volatile Organic Compounds - Sediment. A number of semi-volatile organic compounds were found in Barre Falls Dam sediments, but none in concentrations threatening harm to recreational users or aquatic life. These compounds were either PAHs, which are ubiquitous products of incomplete combustion, or phthalate esters, which are plasticizers and found everywhere in the environment. The only exception was isophorone which belongs to neither of these groups.

(1) PAHs. Measurable quantities of 6 polynuclear aromatic hydrocarbons (PAHs) were reported for Barre Falls Dam sediments--benzo(a)anthracene, chrysene, fluoranthene, naphthalene, phenanthrene, and pyrene. All were in low concentrations and the result of normal activities in the watershed. None were a threat to harm aquatic life forms likely to live in the Barre Falls Reservoir area.

(2) Plasticizers. After the incomplete combustion products, the most common semi-volatile organic compounds detected were plasticizers. Three of these, bis(2-ethylhexyl)phthalate, di-n-butyl-phthalate and diethylphthalate, were also measured in the blank indicating sample contamination as the likely source of much of the measured material. The other plasticizer detected was butylbenzylphthalate. This was found at levels typical of non-contaminated conditions and was not a threat to aquatic life forms likely to live in the Barre Falls Reservoir area. Source of these compounds was likely normal activities in the watershed.

(3) Others. Isophorone was the only detected semi-volatile organic compound which was neither a product of incomplete combustion nor a plasticizer. Little information is available on natural levels of isophorone; however, the reported level was close to the detection limit, there are no known or suspected upstream sources, and there are no indications that chemicals are adversely affecting aquatic life in the area. For those reasons, it was assumed that the measured isophorone level was indicative of natural background levels in the watershed.

9. CONCLUSIONS

Levels of EPA priority pollutants at Barre Falls Dam are low and indicative of natural background conditions. The Barre Falls Dam reservoir area does not represent pristine conditions for certain anthropogenic chemicals are detectable. However, these substances are in low enough concentrations that they are not expected to interfere with aquatic life, water supply, or other uses of the project and its waters. Virtually all metals and organic compounds were found in higher concentrations at the lake station, BF02, than the discharge station, BF10. However, this was due to the higher TOC concentration at station BF02, and is not significant.

Results from this priority pollutant scan at Barre Falls Dam can be used as a reference for natural background conditions when evaluating results from other studies.

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APPENDIX A

BARRE FALLS DAM PRIORITY POLLUTANT SCAN DATA

Note: A complete listing of the data including quality control and quality assurance results are contained in Analytical Data Report, Barre Falls Dam, MA," April 21, 1994, prepared by the U.S. Army Corps of Engineers, New England Division, Environmental Laboratory, Hubbardton, Massachusetts 01452.

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

- POLYCHLORINATED DIOXINS/FURAN RESULTS -

March 31, 1994

Lab#	Field Description	Test	Result	Units	Date Analyzed
B-23669	BF02	Tetrachlorodibenzodioxins	< 2.1	pg/g	10/25/93
		Pentachlorodibenzodioxins	< 6.8		
		Hexachlorodibenzodioxins	< 0.97		
		Heptachlorodibenzodioxins	< 3.5		
		Octachlorodibenzodioxins	< 16		
		Tetrachlorodibenzofurans	< 2.5		
		Pentachlorodibenzofurans	< 1.9		
		Hexachlorodibenzofurans	< 1.3		
		Heptachlorodibenzofurans	< 2.0		
		Octachlorodibenzofurans	< 4.3		
		SURROGATE RECOVERIES:			
		13C12-1,2,3,7,8-PeCDF	69	%	
		13C12-1,2,3,4,6,7,8-HpCDF	95		
		13C12-2,3,7,8-TCDD	69		
		13C12-1,2,3,7,8-PeCDD	61		
		13C12-1,2,3,6,7,8-HxCDD	82		
		13C12-1,2,3,4,6,7,8-HpCDD	78		
		13C12-OCDD	43		
		13C12-2,3,7,8-TCDF	74		

Analyzed By: California Analytical Laboratory / ENSECO Inc.

Approved By:  Chief Chemist

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

- POLYCHLORINATED DIOXINS/FURAN RESULTS -

March 31, 1994

Lab#	Field Description	Test	Result	Units	Date Analyzed
B-23671	BF10	Tetrachlorodibenzodioxins	< 1.1	pg/g	10/25/93
		Pentachlorodibenzodioxins	< 4.6		
		Hexachlorodibenzodioxins	< 2.4		
		Heptachlorodibenzodioxins	< 6.2		
		Octachlorodibenzodioxins	32		
		Tetrachlorodibenzofurans	< 1.3		
		Pentachlorodibenzofurans	< 1.4		
		Hexachlorodibenzofurans	< 0.91		
		Heptachlorodibenzofurans	< 2.0		
		Octachlorodibenzofurans	< 3.3		
		SURROGATE RECOVERIES:			
		13C12-1,2,3,7,8-PeCDF	73	%	
		13C12-1,2,3,4,6,7,8-HpCDF	85		
		13C12-2,3,7,8-TCDD	72		
		13C12-1,2,3,7,8-PeCDD	65		
		13C12-1,2,3,6,7,8-HxCDD	76		
		13C12-1,2,3,4,6,7,8-HpCDD	70		
		13C12-OCDD	37		
		13C12-2,3,7,8-TCDF	76		

Analysed By: California Analytical Laboratory / ENSECO Inc.

Approved By:  , Chief Chemist

U.S. ARMY CORPS OF ENGINEERS
NEW ENGLAND DIVISION, ENVIRONMENTAL LABORATORY

PRODUCED ON

03/31/94

16:26

METHOD BLANK

EPA METHOD 8280: POLYCHLORINATED DIOXINS/FURANS
pg/g

*		METHOD	*
*	PARAMETER	BLANK	*
*			*

*	Tetrachlorodibenzodioxins	< 0.34	*
*	Pentachlorodibenzodioxins	< 0.65	*
*	Hexachlorodibenzodioxins	< 0.57	*
*	Heptachlorodibenzodioxins	< 0.65	*
*	Octachlorodibenzodioxins	< 2.2	*
*			*
*	Tetrachlorodibenzofurans	< 0.16	*
*	Pentachlorodibenzofurans	< 0.39	*
*	Hexachlorodibenzofurans	< 0.25	*
*	Heptachlorodibenzofurans	< 0.24	*
*	Octachlorodibenzofurans	< 1.8	*

*	Internal Standard Recovery (%)		*
*	(40-140)		*
*	13C-2,3,7,8-TCDF	83	*
*	13C-2,3,7,8-TCDD	76	*
*	13C-1,2,3,7,8-PeCDD	68	*
*	13C-1,2,3,6,7,8-HxCDD	86	*
*	13C-1,2,3,4,6,7,8-HpCDD	73	*
*	13C-OCDD	35	*

SAMPLE DATE:

DATE ANALYZED:

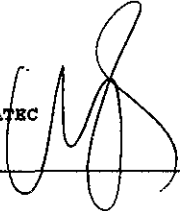
10/25/93

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

March 31, 1994

Lab#	Field Description	Test	Result	Units	Date Analyzed
B-23669	BF02	Total Organic Carbon	8.9	% W/W dry	10/05/93

Analyzed By: AQUATEC

Approved By:  , Chief Chemist

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

March 31, 1994

Lab#	Field Description	Test	Result	Units	Date Analyzed
B-23671	BF10	Total Organic Carbon	3.4	% W/W dry	10/05/93

Analyzed By: AQUATEC

Approved By:  , Chief Chemist

U.S. ARMY CORPS OF ENGINEERS
NEW ENGLAND DIVISION, ENVIRONMENTAL LABORATORY

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PRODUCED ON

04/04/94
14:00

TOC METHOD BLANK

METHOD 9060: TOTAL ORGANIC CARBON (% W/W Dry) - SOIL

ENV NO.

TOTAL ORGANIC CARBON

DATE
ANALYZED

METHOD BLANK

< 0.010

10/5/93

A handwritten signature, possibly reading 'WJ', is located in the bottom left corner of the page.

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

- PCB & PESTICIDE RESULTS -

April 4, 1994

Lab#	Field Description	Test	Result	Units	Date Extracted	Date Analyzed
B-23669	BF02	Total PCBs	J 0.036	mg/kg	09/27/93	10/18/93
		SURROGATE RECOVERIES:			09/27/93	10/18/93
		TCMX (31-115)	93	%	09/27/93	10/18/93
		Alpha-BHC	< 2.8	ug/kg	09/27/93	10/22/93
		Gamma-BHC (Lindane)	< 2.2	ug/kg	09/27/93	10/22/93
		Beta-BHC	< 2.7	ug/kg	09/27/93	10/22/93
		Heptachlor	< 2.6	ug/kg	09/27/93	10/22/93
		Delta-BHC	< 3.0	ug/kg	09/27/93	10/22/93
		Aldrin	< 2.5	ug/kg	09/27/93	10/22/93
		Heptachlor epoxide	< 3.0	ug/kg	09/27/93	10/22/93
		Endosulfan I	J 3.8	ug/kg	09/27/93	10/22/93
		4,4'-DDE	< 4.8	ug/kg	09/27/93	10/22/93
		Dieldrin	< 4.1	ug/kg	09/27/93	10/22/93
		Endrin	< 8.5	ug/kg	09/27/93	10/22/93
		4,4'-DDD	J 5.3	ug/kg	09/27/93	10/22/93
		Endosulfan II	< 3.3	ug/kg	09/27/93	10/22/93
		4,4'-DDT	< 6.1	ug/kg	09/27/93	10/22/93
		Endrin aldehyde	< 3.4	ug/kg	09/27/93	10/22/93
		Endosulfan sulfate	< 3.4	ug/kg	09/27/93	10/22/93
		Methoxychlor	< 3.0	ug/kg	09/27/93	10/22/93
		SURROGATE RECOVERIES:			09/27/93	10/22/93
		TCMX (26-122 sed)	88	%	09/27/93	10/22/93
		Dibutyl chlorodate (60-150)	106	%	09/27/93	10/22/93

Reviewed By: Mark R. Koenig, AnalystApproved By: [Signature], Chief Chemist

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

- PCB & PESTICIDE RESULTS -

March 31, 1994

Lab#	Field Description	Test	Result	Units	Date Extracted	Date Analyzed
B-23671	BF10	Total PCBs	J 0.042	mg/kg	09/27/93	10/18/93
		SURROGATE RECOVERIES:			09/27/93	10/18/93
		TCMX (31-115)	97	%	09/27/93	10/18/93
		Alpha-BHC	< 3.6	ug/kg	10/21/93	10/22/93
		Gamma-BHC (Lindane)	< 2.9	ug/kg	10/21/93	10/22/93
		Beta-BHC	< 3.5	ug/kg	10/21/93	10/22/93
		Heptachlor	< 3.3	ug/kg	10/21/93	10/22/93
		Delta-BHC	< 3.9	ug/kg	10/21/93	10/22/93
		Aldrin	< 3.2	ug/kg	10/21/93	10/22/93
		Heptachlor epoxide	< 3.4	ug/kg	10/21/93	10/22/93

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

- PCB & PESTICIDE RESULTS -

March 31, 1994

Lab#	Field Description	Test	Result	Units	Date Extracted	Date Analyzed
		Heptachlor epoxide	< 4.7	ug/kg	10/21/93	10/22/93
		Endosulfan I	< 6.2	ug/kg	10/21/93	10/22/93
		4,4'-DDE	< 5.3	ug/kg	10/21/93	10/22/93
		Dieldrin	< 11	ug/kg	10/21/93	10/22/93
		Endrin	18	ug/kg	10/21/93	10/22/93
		4,4'-DDD	< 4.2	ug/kg	10/21/93	10/22/93
		Endosulfan II	< 7.8	ug/kg	10/21/93	10/22/93
		4,4'-DDT	< 4.4	ug/kg	10/21/93	10/22/93
		Endrin aldehyde	< 4.4	ug/kg	10/21/93	10/22/93
		Endosulfan sulfate	< 3.9	ug/kg	10/21/93	10/22/93
		Methoxychlor			10/21/93	10/22/93
		SURROGATE RECOVERIES:			10/21/93	10/22/93
		TCMX (26-122)	82	%	10/21/93	10/22/93
		Dibutyl chlorodate (60-150)	99	%	10/21/93	10/22/93

U.S. ARMY CORPS OF ENGINEERS
NEW ENGLAND DIVISION, ENVIRONMENTAL LABORATORY

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PRODUCED ON

04/04/94

10:49

PCB METHOD BLANK
(ppm)

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*****
*                                     *
*      METHOD                         *
*      PARAMETER                     *
*      BLANK                         *
*      SOIL                         *
*                                     *
* Total PCBs                         *
*      < 0.0025                     *
*                                     *
* Surrogate Recovery ( % )          *
*                                     *
* TCMX (31-115) 15 *                *
*                                     *
*****
```

SAMPLE DATE:
DATE RECEIVED:
DATE EXTRACTED: 9/27/93
DATE ANALYZED: 10/21/93

* - Low recovery for TCMX in the method blank could not be explained, but could have gone to dryness in the concentration step.



U.S. ARMY CORPS OF ENGINEERS
NEW ENGLAND DIVISION, ENVIRONMENTAL LABORATORY
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PRODUCED ON 04/04/94
13:12

PESTICIDE METHOD BLANK

METHOD 8080: PESTICIDES - SEDIMENT (ug/kg)

*	METHOD	*
PARAMETER	BLANK	
	SEDIMENT	

* Alpha-BHC	* < 0.29	*
* Gamma-BHC (Lindane)	* < 0.23	*
* Beta-BHC	* < 0.28	*
* Heptachlor	* < 0.27	*
* Delta-BHC	* < 0.32	*
* Aldrin	* < 0.26	*
* Heptachlor epoxide	* < 0.32	*
* Endosulfan I	* < 0.38	*
* 4,4'-DDE	* < 0.50	*
* Dieldrin	* < 0.43	*
* Endrin	* < 0.88	*
* 4,4'-DDD	* < 0.37	*
* Endosulfan II	* < 0.34	*
* 4,4'-DDT	* < 0.63	*
* Endrin aldehyde	* < 0.36	*
* Endosulfan sulfate	* < 0.36	*
* Methoxychlor	* < 0.32	*

* Surrogate Recovery (%)		*
* Dibutyl chlorendate (60-150)	85	*
* TCMX (26-122)	75	*

SAMPLE DATE:
DATE EXTRACTED: 9/27/93
DATE ANALYZED: 10/22/93



U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

- TRACE METAL RESULTS -

April 13, 1994

Lab#	Field Description	Test	Result	Units	Date Digested	Date Analyzed
B-23668	BF02	Silver - Total	< 0.010	ug/mL	02/25/94	03/01/94
		Arsenic - Total	< 0.0030	ug/mL	02/25/94	03/15/94
		Beryllium - Total	< 0.0003	ug/mL	02/25/94	03/01/94
		Cadmium - Total	< 0.0026	ug/mL	02/25/94	03/01/94
		Chromium - Total	< 0.011	ug/mL	02/25/94	03/01/94
		Copper - Total	< 0.0048	ug/mL	02/25/94	03/01/94
		Nickel - Total	< 0.0084	ug/mL	02/25/94	03/01/94
		Lead - Total	< 0.0030	ug/mL	02/25/94	03/11/94
		Antimony - Total	< 0.13	ug/mL	02/25/94	03/01/94
		Selenium - Total	< 0.0030	ug/mL	02/25/94	03/16/94
		Thallium - Total	< 0.0045	ug/mL	02/25/94	03/11/94
		Zinc - Total	0.026	ug/mL	02/25/94	03/01/94
B-23670	BF10	Silver - Total	< 0.010	ug/mL	02/25/94	03/01/94
		Arsenic - Total	< 0.0030	ug/mL	02/25/94	03/15/94
		Beryllium - Total	< 0.0003	ug/mL	02/25/94	03/01/94
		Cadmium - Total	< 0.0026	ug/mL	02/25/94	03/01/94
		Chromium - Total	< 0.011	ug/mL	02/25/94	03/01/94
		Copper - Total	< 0.0048	ug/mL	02/25/94	03/01/94
		Nickel - Total	< 0.0084	ug/mL	02/25/94	03/01/94
		Lead - Total	< 0.0030	ug/mL	02/25/94	03/11/94
		Antimony - Total	< 0.13	ug/mL	02/25/94	03/01/94
		Selenium - Total	< 0.0030	ug/mL	02/25/94	03/16/94
		Thallium - Total	< 0.0045	ug/mL	02/25/94	03/11/94
		Zinc - Total	0.015	ug/mL	02/25/94	03/01/94

Reviewed By: Anne Skipski, AnalystApproved By: [Signature], Chief Chemist

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

- MERCURY RESULTS

April 1, 1994

Lab#	Field Description	Test	Result	Units	Date Digested	Date Analyzed
B-23668	BF02	Mercury - Total	< 0.0004	ug/mL	09/29/93	09/30/93
B-23670	BF10	Mercury - Total	< 0.0004	ug/mL	09/29/93	09/30/93

Reviewed By: Anne S. Skelton, AnalystApproved By: [Signature], Chief Chemist

- TRACE METAL RESULTS -

Lab#	Field Description	Test	Result	Units	Date Digested	Date Analyzed
B-23669	BF02	Silver	< 1.2	ug/g	02/08/94	02/15/94
		Arsenic	5.4	ug/g	02/08/94	03/01/94
		Beryllium	4.2	ug/g	02/08/94	02/15/94
		Cadmium	0.93	ug/g	02/08/94	02/15/94
		Chromium	16	ug/g	02/08/94	02/15/94
		Copper	11	ug/g	02/08/94	02/15/94
		Nickel	14	ug/g	02/08/94	02/15/94
		Lead	28	ug/g	02/08/94	03/01/94
		Antimony	< 14	ug/g	02/08/94	02/15/94
		Selenium	J 1.5	ug/g	02/08/94	03/01/94
		Thallium	< 0.51	ug/g	02/08/94	02/28/94
		Zinc	63	ug/g	02/08/94	02/15/94
B-23671	BF10	Silver	< 1.2	ug/g	02/08/94	02/15/94
		Arsenic	2.4	ug/g	02/08/94	03/01/94
		Beryllium	0.14	ug/g	02/08/94	02/15/94
		Cadmium	0.51	ug/g	02/08/94	02/15/94
		Chromium	8.2	ug/g	02/08/94	02/15/94
		Copper	4.8	ug/g	02/08/94	02/15/94
		Nickel	4.8	ug/g	02/08/94	02/15/94
		Lead	21	ug/g	02/08/94	03/01/94
		Antimony	< 14	ug/g	02/08/94	02/15/94
		Selenium	J 0.68	ug/g	02/08/94	03/01/94
		Thallium	J 0.51	ug/g	02/08/94	02/28/94
		Zinc	29	ug/g	02/08/94	02/15/94

Reviewed By: Anne S. Hobbs, Analyst

Approved By: _____, Chief Chemist

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

- MERCURY RESULTS

April 4, 1994

Lab#	Field Description	Test	Result	Units	Date Digested	Date Analyzed
B-23669	BF02	Mercury	*	ug/g		
B-23671	BF10	Mercury	*	ug/g		

* - Digestate lost in fire.

Reviewed By: Anna A. Blaski, AnalystApproved By: [Signature], Chief Chemist

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 1039 1040 1041 1042 1043 1044

10:15

TRACE METAL RESULTS - SOIL (ppm)

DATE DIGESTED: 02/08/94
DATE ANALYZED: 02/15/94 - 03/01/94

* - No QC available - digestate lost in fire.

AMS



U. S. ARMY CORPS OF ENGINEERS
NEW ENGLAND DIVISION, ENVIRONMENTAL LABORATORY

=====

PRODUCED ON

04/01/94
13:59

METHOD BLANK DATA FOR DIGESTION DATE 02/25/94

TRACE METAL RESULTS - WATER (ppm)

```
*****
*          *          METHOD          *
*  PARAMETER  *          BLANK          *
*          *          WATER          *
*****
* Silver      *          < 0.010          *
* Arsenic     *          < 0.0030         *
* Beryllium   *          < 0.0003         *
* Cadmium     *          < 0.0025         *
* Chromium    *          < 0.011          *
* Copper      *          0.0084           *
* Mercury     *          < 0.0004         *
* Nickel      *          < 0.0084         *
* Lead        *          < 0.0030         *
* Antimony    *          < 0.13           *
* Selenium    *          < 0.0030         *
* Thallium    *          < 0.0045         *
* Zinc        *          0.0083           *
*****
```

DATE DIGESTED: 2/25/94
DATE ANALYZED: 03/01/93 - 03/16/94

Mercury was digested on 9/29/93 and analyzed on 9/30/94.

AMS

UG

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

Volatile Organic Results - Method 8260

April 4, 1994

Lab#	Field Description	Dil Factor	Analyte	Result	Units	Sample Date	Date Analyzed
B-23667	TB-1	1.00	Chloromethane	<	9.6 ug/L	09/22/93	09/23/93
			Vinyl chloride	<	14 ug/L		
			Bromomethane	<	16 ug/L		
			Chloroethane	<	15 ug/L		
			1,1-Dichloroethane	<	0.58 ug/L		
			Acetone	J	3.9 ug/L		
			Carbon disulfide	<	0.60 ug/L		
			Methylene chloride	B	7.2 ug/L		
			trans-1,2-Dichloroethane	<	0.64 ug/L		
			1,1-Dichloroethane	<	0.53 ug/L		
			cis 1,2-Dichloroethane	<	0.52 ug/L		
			Chloroform		7.7 ug/L		
			1,2-Dichloroethane	<	0.41 ug/L		
			2-Butanone	<	1.6 ug/L		
			1,1,1-Trichloroethane	<	0.39 ug/L		
			Carbon Tetrachloride	<	0.36 ug/L		
			Benzene	<	0.63 ug/L		
			Trichloroethane	<	0.59 ug/L		
			1,2-Dichloropropane	<	0.45 ug/L		
			Bromodichloromethane	<	0.38 ug/L		
			cis 1,3-Dichloropropene	<	0.48 ug/L		
			trans 1,3-Dichloropropene	<	0.60 ug/L		
			4-Methyl-2-pentanone	<	1.5 ug/L		
			Toluene	<	0.58 ug/L		
			1,1,2-Trichloroethane	<	0.62 ug/L		
			Tetrachloroethane	<	0.46 ug/L		
			2-Hexanone	<	1.2 ug/L		
			Dibromochloromethane	<	0.57 ug/L		
			Chlorobenzene	<	0.75 ug/L		
			Ethylbenzene	<	0.56 ug/L		
			m/p Xylene	<	1.1 ug/L		
			o-Xylene	<	0.37 ug/L		
			Styrene	<	0.34 ug/L		
			Bromoform	<	0.98 ug/L		
			1,1,2,2-Tetrachloroethane	<	0.86 ug/L		

SURROGATE RECOVERIES:

1.00	1,2-Dichloroethane-D4 (76-114)	105	%
	Toluene-D8 (88-110)	91	%
	4-Bromofluorobenzene (86-115)	85	%

Analyzed By: _____

Approved By: _____

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

Volatile Organic Results - Method 8260

March 31, 1994

Lab#	Field Description	Dil Factor	Analyte	Result	Units	Sample Date	Date Analyzed
B-23669	BF02	4.56	Chloromethane	<	44 ng/g	09/22/93	09/23/93
			Vinyl chloride	<	63 ng/g		
			Bromomethane	<	74 ng/g		
			Chloroethane	<	70 ng/g		
			1,1-Dichloroethane	<	2.6 ng/g		
			Acetone		460 ng/g		
			Carbon disulfide	<	2.7 ng/g		
			Methylene chloride	B	51 ng/g		
			trans-1,2-Dichloroethane	<	2.9 ng/g		
			1,1-Dichloroethane	<	2.4 ng/g		
			cis 1,2-Dichloroethane	<	2.4 ng/g		
			Chloroform	<	2.7 ng/g		
			1,2-Dichloroethane	<	1.9 ng/g		
			2-Butanone (MEK)		180 ng/g		
			1,1,1-Trichloroethane	<	1.8 ng/g		
			Carbon Tetrachloride	<	1.6 ng/g		
			Benzene	<	2.9 ng/g		
			Trichloroethane	<	2.7 ng/g		
			1,2-Dichloropropane	<	2.1 ng/g		
			Bromodichloromethane	<	1.7 ng/g		
			cis 1,3-Dichloropropene	<	2.2 ng/g		
			trans 1,3-Dichloro, 1-propene	<	2.7 ng/g		
			4-Methyl-2-pentanone (MIBK)	<	6.7 ng/g		
			Toluene	<	2.6 ng/g		
			1,1,2-Trichloroethane	<	2.8 ng/g		
			Tetrachloroethane	<	2.1 ng/g		
			2-Hexanone	<	5.4 ng/g		
			Dibromochloromethane	<	2.6 ng/g		
			Chlorobenzene	<	3.4 ng/g		
			Ethylbenzene	<	2.6 ng/g		
			m/p Xylene	<	5.0 ng/g		
			o-Xylene	<	1.7 ng/g		
			Styrene	<	1.6 ng/g		
			Bromoform	<	4.5 ng/g		
			1,1,2,2-Tetrachloroethane	<	3.9 ng/g		
SURROGATE RECOVERIES:							
		1.00	1,2-Dichloroethane-D4 (70-121)	109	%		
			Toluene-D8 (81-117)	108	%		
			4-Bromofluorobenzene (74-121)	72	%		

Analyzed By: _____

Approved By: _____

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

Volatile Organic Results - Method 8260

April 4, 1994

Lab#	Field Description	Dil Factor	Analyte	Result	Units	Sample Date	Date Analyzed
B-23671	BF10	3.63	Chloromethane	<	35 ng/g	09/22/93	09/23/93
			Vinyl chloride	<	50 ng/g		
			Bromomethane	<	59 ng/g		
			Chloroethane	<	56 ng/g		
			1,1-Dichloroethane	<	2.1 ng/g		
			Acetone	<	98 ng/g		
			Carbon disulfide	<	2.2 ng/g		
			Methylene chloride	B	38 ng/g		
			trans-1,2-Dichloroethane	<	2.3 ng/g		
			1,1-Dichloroethane	<	1.9 ng/g		
			cis 1,2-Dichloroethane	<	1.9 ng/g		
			Chloroform	<	2.1 ng/g		
			1,2-Dichloroethane	<	1.5 ng/g		
			2-Butanone (MEK)		33 ng/g		
			1,1,1-Trichloroethane	<	1.4 ng/g		
			Carbon Tetrachloride	<	1.3 ng/g		
			Benzene	<	2.3 ng/g		
			Trichloroethane	<	2.1 ng/g		
			1,2-Dichloropropane	<	1.6 ng/g		
			Bromodichloromethane	<	1.4 ng/g		
			cis 1,3-Dichloropropene	<	1.7 ng/g		
			trans 1,3-Dichloro, 1-propene	<	2.2 ng/g		
			4-Methyl-2-pentanone (MIB)	<	5.3 ng/g		
			Toluene	<	2.1 ng/g		
			1,1,2-Trichloroethane	<	2.3 ng/g		
			Tetrachloroethane	<	1.7 ng/g		
			2-Hexanone	<	4.3 ng/g		
			Dibromochloromethane	<	2.1 ng/g		
			Chlorobenzene	<	2.7 ng/g		
			Ethylbenzene	<	2.0 ng/g		
			m/p Xylene	<	4.0 ng/g		
			o-Xylene	<	1.3 ng/g		
			Styrene	<	1.2 ng/g		
			Bromoform	<	3.6 ng/g		
			1,1,2,2-Tetrachloroethane	<	3.1 ng/g		

SURROGATE RECOVERIES:

1.00	1,2-Dichloroethane-D4 (70-121)	111	%
	Toluene-D8 (81-117)	100	%
	4-Bromofluorobenzene (74-121)	74	%

Analyzed By: _____

Approved By: _____

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

METHOD 8240: VOLATILE ORGANICS - WATER (ug/L)

05-Apr-94

Field Description	Dil Factor	Analyte	Result	Units	Date Analyzed
METHOD BLANK	1.0	Chloromethane	< 10	ug/L	9/23/93
		Vinyl chloride	< 14	ug/L	
		Bromomethane	< 16	ug/L	
		Chloroethane	< 15	ug/L	
		1,1-Dichloroethene	< 0.58	ug/L	
		Acetone	< 2.1	ug/L	
		Carbon disulfide	< 0.60	ug/L	
		Methylene chloride	9.1	ug/L	
		trans-1,2-Dichloroethene	< 0.64	ug/L	
		1,1-Dichloroethane	< 0.53	ug/L	
		cis-1,2-Dichloroethene	< 0.52	ug/L	
		Chloroform	< 0.59	ug/L	
		1,2-Dichloroethane	< 0.41	ug/L	
		2-Butanone	< 1.6	ug/L	
		1,1,1-Trichloroethane	< 0.39	ug/L	
		Carbon tetrachloride	< 0.36	ug/L	
		Benzene	< 0.63	ug/L	
		Trichloroethene	< 0.59	ug/L	
		1,2-Dichloropropane	< 0.45	ug/L	
		Bromodichloromethane	< 0.38	ug/L	
		cis-1,3-Dichloro, 1-propene	< 0.48	ug/L	
		trans-1,3-Dichloro, 1-propene	< 0.60	ug/L	
		4-Methyl-2-pentanone	< 1.5	ug/L	
		Toluene	< 0.58	ug/L	
		1,1,2-Trichloroethane	< 0.62	ug/L	
		Tetrachloroethene	< 0.46	ug/L	
		2-Hexanone	< 1.2	ug/L	
		Dibromochloromethane	< 0.57	ug/L	
		Chlorobenzene	< 0.75	ug/L	
		Ethylbenzene	< 0.56	ug/L	
		m/p Xylene	< 1.1	ug/L	
		O-Xylene	< 0.37	ug/L	
		Styrene	< 0.34	ug/L	
		Bromoform	< 1.0	ug/L	
		1,1,2,2-Tetrachloroethane	< 0.86	ug/L	
Surrogate Recovery					
		1,2-Dichloroethane D4 (76-114)	102	%	
		Toluene D8 (88-110)	96	%	
		4-Bromofluorobenzene (86-115)	78	%	

Reviewed By:  AnalystApproved By: 

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

METHOD 8260: VOLATILE ORGANICS - SEDIMENT (ng/g)

29-Sep-94

Field Description	Dil Factor	Analyte	Result	Units	Date Analyzed
METHOD BLANK	1.0	Chloromethane	<	10	ng/g
		Vinyl chloride	<	14	ng/g
		Bromomethane	<	16	ng/g
		Chloroethane	<	15	ng/g
		1,1-Dichloroethane	<	0.58	ng/g
		Acetone	<	9.1	ng/g
		Carbon disulfide	<	0.60	ng/g
		Methylene chloride	<	0.51	ng/g
		trans-1,2-Dichloroethane	<	0.64	ng/g
		1,1-Dichloroethane	<	0.53	ng/g
		cis-1,2-Dichloroethane	<	0.52	ng/g
		Chloroform	<	0.59	ng/g
		1,2-Dichloroethane	<	0.41	ng/g
		2-Butanone	<	1.6	ng/g
		1,1,1-Trichloroethane	<	0.39	ng/g
		Carbon tetrachloride	<	0.36	ng/g
		Benzene	<	0.63	ng/g
		Trichloroethane	<	0.59	ng/g
		1,2-Dichloropropane	<	0.45	ng/g
		Bromodichloromethane	<	0.38	ng/g
		cis-1,3-Dichloro, 1-propene	<	0.48	ng/g
		trans-1,3-Dichloro, 1-propene	<	0.60	ng/g
		4-Methyl-2-pentanone	<	1.5	ng/g
		Toluene	<	0.58	ng/g
		1,1,2-Trichloroethane	<	0.62	ng/g
		Tetrachloroethane	<	0.46	ng/g
		2-Hexanone	<	1.2	ng/g
		Dibromochloromethane	<	0.57	ng/g
		Chlorobenzene	<	0.75	ng/g
		Ethylbenzene	<	0.56	ng/g
		m/p Xylene	<	1.1	ng/g
		O-Xylene	<	0.37	ng/g
		Styrene	<	0.34	ng/g
		Bromoform	<	1.0	ng/g
		1,1,2,2-Tetrachloroethane	<	0.86	ng/g
Surrogate Recovery					
		1,2-Dichloroethane D4 (70-121)	102	%	
		Toluene D8 (81-117)	96	%	
		4-Bromofluorobenzene (74-121)	78	%	

Reviewed By: , AnalystApproved By: 

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

SEMI-VOLATILE ORGANIC RESULTS - METHOD 8270

April 5, 1994

Lab#	Field Description	Dil Factor	Analyte	Result	Units	Sample Date	Date Extracted	Date Analyzed
B-23668	BF02	1.13	Aniline	<	0.97 ug/L	09/22/93	09/28/93	10/18/93
			Phenol	<	0.76 ug/L			
			bis(2-Chloroethyl)ether	<	0.28 ug/L			
			2-Chlorophenol	<	0.20 ug/L			
			1,3-Dichlorobenzene	<	0.16 ug/L			
			1,4-Dichlorobenzene	<	0.090 ug/L			
			1,2-Dichlorobenzene	<	0.17 ug/L			
			Benzyl Alcohol	<	5.6 ug/L			
			2-Methylphenol	<	1.6 ug/L			
			bis(2-Chloroisopropyl)ether	<	0.46 ug/L			
			4-Methylphenol	<	1.1 ug/L			
			N-Nitroso-di-n-propylamine	<	0.29 ug/L			
			Hexachloroethane	<	0.17 ug/L			
			Nitrobenzene	<	0.36 ug/L			
			Isophorone	<	0.36 ug/L			
			2-Nitrophenol	<	0.78 ug/L			
			2,4-Dimethylphenol	<	2.1 ug/L			
			Benzoic acid	<	79 ug/L			
			bis(2-Chloroethoxy)methane	<	0.26 ug/L			
			2,4-Dichlorophenol	<	2.5 ug/L			
			1,2,4-Trichlorobenzene	<	0.11 ug/L			
			Naphthalene	J,B	0.14 ug/L			
			4-Chloroaniline	<	1.9 ug/L			
			Hexachlorobutadiene	<	0.12 ug/L			
			4-Chloro-3-methylphenol	<	1.7 ug/L			
			2-Methylnaphthalene	<	0.16 ug/L			
			Hexachlorocyclopentadiene	<	1.1 ug/L			
			2,4,6-Trichlorophenol	<	1.7 ug/L			
			2,4,5-Trichlorophenol	<	1.5 ug/L			
			2-Chloronaphthalene	<	0.20 ug/L			
			2-Nitroaniline	<	1.3 ug/L			
			Dimethyl phthalate	<	0.19 ug/L			
			Acenaphthylene	<	0.12 ug/L			
			3-Nitroaniline	<	10 ug/L			
			Acenaphthene	<	0.15 ug/L			
			2,4-Dinitrophenol	<	74 ug/L			
			4-Nitrophenol	<	39 ug/L			
			Dibenzofuran	<	0.12 ug/L			
			2,6-Dinitrotoluene	<	0.42 ug/L			
			2,4-Dinitrotoluene	<	0.86 ug/L			
			Diethylphthalate	B	0.58 ug/L			
			4-Chlorophenyl-phenylether	<	0.16 ug/L			
			Fluorene	<	0.18 ug/L			
			4-Nitroaniline	<	2.1 ug/L			
			4,6-Dinitro-2-methylphenol	<	35 ug/L			
			N-Nitrosodiphenylamine	<	0.26 ug/L			
			4-Bromophenyl-phenylether	<	0.18 ug/L			
			Hexachlorobenzene	<	0.15 ug/L			
			Pentachlorophenol	<	34 ug/L			
			Phenanthrene	<	0.15 ug/L			
			Anthracene	<	0.24 ug/L			
			Di-n-butylphthalate	<	0.46 ug/L			
			Fluoranthene	<	0.18 ug/L			
			Pyrene	<	0.16 ug/L			
			Butylbenzylphthalate	<	0.44 ug/L			
			3,3-Dichlorobenzidine	<	0.58 ug/L			
			Benzo(a)anthracene	<	0.15 ug/L			
			bis-(2-Ethylhexyl)phthalate	<	0.71 ug/L			
			Chrysene	<	0.15 ug/L			
			Di-n-octyl phthalate	<	1.8 ug/L			
			Benzo(b)fluoranthene	<	0.41 ug/L			
			Benzo(k)fluoranthene	<	0.70 ug/L			
			Benzo(a)pyrene	<	0.45 ug/L			
			Indeno(1,2,3-cd)pyrene	<	0.15 ug/L			
			Dibenz(a,h)anthracene	<	0.15 ug/L			
			Benzo(g,h,i)perylene	<	0.15 ug/L			

Reviewed By:  Analyst

Approved By:

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

SEMI-VOLATILE ORGANIC RESULTS - METHOD 8270

March 31, 1994

Lab#	Field Description	Dil Factor	Analyte	Result	Units	Sample Date	Date Extracted	Date Analyzed
B-23668	BF02		SURROGATE RECOVERIES:			09/22/93	09/28/93	10/18/93
		1.00	2-Fluorophenol (25-121)	83	%			
			Phenol-d6 (21-100)	63	%			
			Nitrobenzene-d5 (35-114)	94	%			
			2-Fluorobiphenyl (43-116)	64	%			
			2,4,6-Tribromophenol (10-123)	96	%			
			Terphenyl-d14 (33-141)	86	%			

Reviewed By:  , AnalystApproved By: 

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

SEMI-VOLATILE ORGANIC RESULTS - METHOD 8270

March 31, 1994

Lab#	Field Description	Dil Factor	Analyte	Result	Units	Sample Date	Date Extracted	Date Analyzed
B-23669	BF02	0.30	Aniline	< 0.25	ug/g	09/22/93	09/27/93	10/09/93
			Phenol	< 0.20	ug/g			
			bis(2-Chloroethyl) ether	< 0.074	ug/g			
			2-Chlorophenol	< 0.053	ug/g			
			1,3-Dichlorobenzene	< 0.041	ug/g			
			1,4-Dichlorobenzene	< 0.024	ug/g			
			1,2-Dichlorobenzene	< 0.044	ug/g			
			Benzyl Alcohol	< 1.5	ug/g			
			2-Methylphenol	< 0.41	ug/g			
			bis(2-Chloroisopropyl) ether	< 0.12	ug/g			
			4-Methylphenol	< 0.28	ug/g			
			N-Nitroso-di-n-propylamine	< 0.077	ug/g			
			Hexachlorthane	< 0.044	ug/g			
			Nitrobenzene	< 0.095	ug/g			
			Isophorone	J 0.27	ug/g			
			2-Nitrophenol	< 0.20	ug/g			
			2,4-Dimethylphenol	< 0.55	ug/g			
			Benzoic acid	< 21	ug/g			
			bis(2-Chloroethoxy)methane	< 0.068	ug/g			
			2,4-Dichlorophenol	< 0.64	ug/g			
			1,2,4-Trichlorobenzene	< 0.030	ug/g			
			Naphthalene	B 0.10	ug/g			
			4-Chloroaniline	< 0.51	ug/g			
			Hexachlorbutadiene	< 0.032	ug/g			
			4-Chloro-3-methylphenol	< 0.44	ug/g			
			2-Methylnaphthalene	< 0.041	ug/g			
			Hexachlorocyclopentadiene	< 0.29	ug/g			
			2,4,6-Trichlorophenol	< 0.45	ug/g			
			2,4,5-Trichlorophenol	< 0.39	ug/g			
			2-Chloronaphthalene	< 0.053	ug/g			
			2-Nitroaniline	< 0.34	ug/g			
			Dimethyl phthalate	< 0.050	ug/g			
			Acenaphthylene	< 0.032	ug/g			
			3-Nitroaniline	< 2.7	ug/g			
			Acenaphthene	< 0.038	ug/g			
			2,4-Dinitrophenol	< 19	ug/g			
			4-Nitrophenol	< 10	ug/g			
			Dibenzofuran	< 0.032	ug/g			
			2,6-Dinitrotoluene	< 0.11	ug/g			
			2,4-Dinitrotoluene	< 0.22	ug/g			
			Diethylphthalate	B 0.38	ug/g			
			4-Chlorophenyl-phenylether	< 0.041	ug/g			
			Fluorene	< 0.047	ug/g			
			4-Nitroaniline	< 0.56	ug/g			
			4,6-Dinitro-2-methylphenol	< 9.1	ug/g			
			N-Nitrosodiphenylamine	< 0.068	ug/g			
			4-Bromophenyl-phenylether	< 0.047	ug/g			
			Hexachlorobenzene	< 0.038	ug/g			
			Pentachlorophenol	< 8.9	ug/g			
			Phenanthrene	J 0.11	ug/g			
			Anthracene	< 0.062	ug/g			
			Di-n-butylphthalate	B 1.7	ug/g			
			Fluoranthene	J 0.12	ug/g			
			Pyrene	J 0.10	ug/g			
			Butylbenzylphthalate	J 0.15	ug/g			
			3,3-Dichlorobenzidine	< 0.15	ug/g			
			Benzo(a)anthracene	J 0.065	ug/g			
			bis-(2-Ethylhexyl)phthalate	J 0.38	ug/g			
			Chrysene	J 0.053	ug/g			
			Di-n-octyl phthalate	< 0.46	ug/g			
			Benzo(b)fluoranthene	< 0.11	ug/g			
			Benzo(k)fluoranthene	< 0.18	ug/g			
			Benzo(a)pyrene	< 0.12	ug/g			
			Indeno(1,2,3-cd)pyrene	< 0.038	ug/g			
			Dibenz(a,h)anthracene	< 0.038	ug/g			
			Benzo(g,h,i)perylene	< 0.038	ug/g			

Reviewed By: , Analyst

Approved By: _____

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

SEMI-VOLATILE ORGANIC RESULTS - METHOD 8270

March 31, 1994

Lab#	Field Description	Dil Factor	Analyte	Result	Units	Sample Date	Date Extracted	Date Analyzed
B-23669	BF02		SURROGATE RECOVERIES:			09/22/93	09/27/93	10/09/93
		1.00	2-Fluorophenol (25-121)	94	%			
			Phenol-d6 (24-113)	117	%			
			Nitrobenzene-d5 (23-120)	93	%			
			2-Fluorobiphenyl (30-115)	73	%			
			2,4,6-Tribromophenol (19-122)	136	%			
			Terphenyl-d14 (18-137)	103	%			

Reviewed By:  , Analyst

Approved By: _____

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

SEMI-VOLATILE ORGANIC RESULTS - METHOD 8270

March 31, 1994

Lab#	Field Description	Dil Factor	Analyte	Result	Units	Sample	Date	Date
						Date	Extracted	Analyzed
B-23670	BF10	1.06	Aniline	<	0.91	ug/L	09/22/93	09/28/93
			Phenol	<	0.71	ug/L		10/18/93
			bis(2-Chloroethyl) ether	<	0.27	ug/L		
			2-Chlorophenol	<	0.19	ug/L		
			1,3-Dichlorobenzene	<	0.15	ug/L		
			1,4-Dichlorobenzene	<	0.085	ug/L		
			1,2-Dichlorobenzene	<	0.16	ug/L		
			Benzyl Alcohol	<	5.3	ug/L		
			2-Methylphenol	<	1.5	ug/L		
			bis(2-Chloroisopropyl) ether	<	0.44	ug/L		
			4-Methylphenol	<	1.0	ug/L		
			N-Nitroso-di-n-propylamine	<	0.28	ug/L		
			Hexachloroethane	<	0.16	ug/L		
			Nitrobenzene	<	0.34	ug/L		
			Isophorone	<	0.34	ug/L		
			2-Nitrophenol	<	0.73	ug/L		
			2,4-Dimethylphenol	<	2.0	ug/L		
			Benzoic acid	<	75	ug/L		
			bis(2-Chloroethoxy) methane	<	0.24	ug/L		
			2,4-Dichlorophenol	<	2.3	ug/L		
			1,2,4-Trichlorobenzene	<	0.11	ug/L		
			Naphthalene	<	0.074	ug/L		
			4-Chloroaniline	<	1.8	ug/L		
			Hexachlorobutadiene	<	0.12	ug/L		
			4-Chloro-3-methylphenol	<	1.6	ug/L		
			2-Methylnaphthalene	<	0.15	ug/L		
			Hexachlorocyclopentadiene	<	1.1	ug/L		
			2,4,6-Trichlorophenol	<	1.6	ug/L		
			2,4,5-Trichlorophenol	<	1.4	ug/L		
			2-Chloronaphthalene	<	0.19	ug/L		
			2-Nitroaniline	<	1.2	ug/L		
			Dimethyl phthalate	<	0.18	ug/L		
			Acenaphthylene	<	0.12	ug/L		
			3-Nitroaniline	<	9.6	ug/L		
			Acenaphthene	<	0.14	ug/L		
			2,4-Dinitrophenol	<	69	ug/L		
			4-Nitrophenol	<	37	ug/L		
			Dibenzofuran	<	0.12	ug/L		
			2,6-Dinitrotoluene	<	0.39	ug/L		
			2,4-Dinitrotoluene	<	0.81	ug/L		
			Diethylphthalate	<	0.27	ug/L		
			4-Chlorophenyl-phenylether	<	0.15	ug/L		
			Fluorene	<	0.17	ug/L		
			4-Nitroaniline	<	2.0	ug/L		
			4,6-Dinitro-2-methylphenol	<	33	ug/L		
			N-Nitrosodiphenylamine	<	0.24	ug/L		
			4-Bromophenyl-phenylether	<	0.17	ug/L		
			Hexachlorobenzene	<	0.14	ug/L		
			Pentachlorophenol	<	32	ug/L		
			Phenanthrene	<	0.14	ug/L		
			Anthracene	<	0.22	ug/L		
			Di-n-butylphthalate	<	0.44	ug/L		
			Fluoranthene	<	0.17	ug/L		
			Pyrene	<	0.15	ug/L		
			Butylbenzylphthalate	<	0.41	ug/L		
			3,3-Dichlorobenzidine	<	0.54	ug/L		
			Benzo(a)anthracene	<	0.14	ug/L		
			bis-(2-Ethylhexyl)phthalate	<	0.67	ug/L		
			Chrysene	<	0.14	ug/L		
			Di-n-octyl phthalate	<	1.6	ug/L		
			Benzo(b)fluoranthene	<	0.38	ug/L		
			Benzo(k)fluoranthene	<	0.66	ug/L		
			Benzo(a)pyrene	<	0.43	ug/L		
			Indeno(1,2,3-cd)pyrene	<	0.14	ug/L		
			Dibenz(a,h)anthracene	<	0.14	ug/L		
			Benzo(g,h,i)perylene	<	0.14	ug/L		

Reviewed By:  , Analyst

Approved By: _____

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

SEMI-VOLATILE ORGANIC RESULTS - METHOD 8270

March 31, 1994

Lab#	Field Description	Dil Factor	Analyte	Result	Units	Sample Date	Date Extracted	Date Analyzed
B-23670	BF10		SURROGATE RECOVERIES:			09/22/93	09/28/93	10/18/93
		1.00	2-Fluorophenol (10-94)	80	%			
			Phenol-d6 (21-100)	58	%			
			Nitrobenzene-d5 (35-114)	90	%			
			2-Fluorobiphenyl (43-116)	64	%			
			2,4,6-Tribromophenol (10-123)	94	%			
			Terphenyl-d14 (33-141)	85	%			

Reviewed By:  , AnalystApproved By: 

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

SEMI-VOLATILE ORGANIC RESULTS - METHOD 8270

April 4, 1994

Lab#	Field Description	Dil Factor	Analyte	Result	Units	Sample Date	Date Extracted	Date Analyzed
B-23671	BF10	0.62	Aniline	< 0.54	ug/g	09/22/93	09/27/93	10/09/93
			Phenol	< 0.42	ug/g			
			bis(2-Chloroethyl)ether	< 0.16	ug/g			
			2-Chlorophenol	< 0.11	ug/g			
			1,3-Dichlorobenzene	< 0.087	ug/g			
			1,4-Dichlorobenzene	< 0.050	ug/g			
			1,2-Dichlorobenzene	< 0.093	ug/g			
			Benzyl Alcohol	< 3.1	ug/g			
			2-Methylphenol	< 0.86	ug/g			
			bis(2-Chloroisopropyl)ether	< 0.26	ug/g			
			4-Methylphenol	< 0.59	ug/g			
			N-Nitroso-di-n-propylamine	< 0.16	ug/g			
			Hexachlorethane	< 0.093	ug/g			
			Nitrobenzene	< 0.20	ug/g			
			Isophorone	< 0.20	ug/g			
			2-Nitrophenol	< 0.43	ug/g			
			2,4-Dimethylphenol	< 1.2	ug/g			
			Benzoic acid	< 44	ug/g			
			bis(2-Chloroethoxy)methane	< 0.14	ug/g			
			2,4-Dichlorophenol	< 1.4	ug/g			
			1,2,4-Trichlorobenzene	< 0.062	ug/g			
			Naphthalene	B 0.18	ug/g			
			4-Chloroaniline	< 1.1	ug/g			
			Hexachlorobutadiene	< 0.069	ug/g			
			4-Chloro-3-methylphenol	< 0.93	ug/g			
			2-Methylnaphthalene	< 0.087	ug/g			
			Hexachlorocyclopentadiene	< 0.62	ug/g			
			2,4,6-Trichlorophenol	< 0.94	ug/g			
			2,4,5-Trichlorophenol	< 0.83	ug/g			
			2-Chloronaphthalene	< 0.11	ug/g			
			2-Nitroaniline	< 0.72	ug/g			
			Dimethyl phthalate	< 0.11	ug/g			
			Acenaphthylene	< 0.069	ug/g			
			3-Nitroaniline	< 5.6	ug/g			
			Acenaphthene	< 0.081	ug/g			
			2,4-Dinitrophenol	< 41	ug/g			
			4-Nitrophenol	< 22	ug/g			
			Dibenzofuran	< 0.069	ug/g			
			2,6-Dinitrotoluene	< 0.23	ug/g			
			2,4-Dinitrotoluene	< 0.47	ug/g			
			Diethylphthalate	B 1.1	ug/g			
			4-Chlorophenyl-phenylether	< 0.087	ug/g			
			Fluorene	< 0.10	ug/g			
			4-Nitroaniline	< 1.2	ug/g			
			4,6-Dinitro-2-methylphenol	< 19	ug/g			
			N-Nitrosodiphenylamine	< 0.14	ug/g			
			4-Bromophenyl-phenylether	< 0.10	ug/g			
			Hexachlorobenzene	< 0.081	ug/g			
			Pentachlorophenol	< 19	ug/g			
			Phenanthrene	J 0.12	ug/g			
			Anthracene	< 0.13	ug/g			
			Di-n-butylphthalate	B 20	ug/g			
			Fluoranthene	< 0.10	ug/g			
			Pyrene	< 0.087	ug/g			
			Butylbenzylphthalate	< 0.24	ug/g			
			3,3-Dichlorobenzidine	< 0.32	ug/g			
			Benzo(a)anthracene	< 0.081	ug/g			
			bis-(2-Ethylhexyl)phthalate	< 0.39	ug/g			
			Chrysene	< 0.081	ug/g			
			Di-n-octyl phthalate	< 0.97	ug/g			
			Benzo(b)fluoranthene	< 0.22	ug/g			
			Benzo(k)fluoranthene	< 0.39	ug/g			
			Benzo(a)pyrene	< 0.25	ug/g			
			Indeno(1,2,3-cd)pyrene	< 0.081	ug/g			
			Dibenz(a,h)anthracene	< 0.081	ug/g			
			Benzo(g,h,i)perylene	< 0.081	ug/g			

Reviewed By:  Analyst

Approved By: _____

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

SEMI-VOLATILE ORGANIC RESULTS - METHOD 8270

April 4, 1994

Lab#	Field Description	Dil Factor	Analyte	Result	Units	Sample Date	Date Extracted	Date Analyzed
B-23671	BF10		SURROGATE RECOVERIES:			09/22/93	09/27/93	10/09/93
		1.00	2-Fluorophenol (25-121)	104	%			
			Phenol-d6 (24-113)	95	%			
			Nitrobenzene-d5 (23-120)	92	%			
			2-Fluorobiphenyl (30-115)	72	%			
			2,4,6-Tribromophenol (19-122)	120	%			
			Terphenyl-d14 (18-137)	95	%			

Reviewed By:  AnalystApproved By: 

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

SEMI-VOLATILE ORGANIC RESULTS - METHOD 8270

05-Apr-94

Field Description	Analyte	Dilution Factor		Result	Units	Date Extracted	Date Analyzed
METHOD BLANK	Aniline	0.048	<	0.041	ug/g	9/27/93	10/8/93
	Phenol		<	0.032	ug/g		
	Bis(2-chloroethyl) ether		<	0.012	ug/g		
	2-Chlorophenol		<	0.0086	ug/g		
	1,3-Dichlorobenzene		<	0.0067	ug/g		
	1,4-Dichlorobenzene		<	0.0038	ug/g		
	1,2-Dichlorobenzene		<	0.0072	ug/g		
	Benzyl alcohol		<	1.3	ug/g		
	2-Methylphenol		<	0.066	ug/g		
	Bis(2-chloroisopropyl) ether		<	0.020	ug/g		
	4-Methylphenol		<	0.046	ug/g		
	N-Nitroso-di-n-propylamine		<	0.012	ug/g		
	Hexachloroethane		<	0.0072	ug/g		
	Nitrobenzene		<	0.015	ug/g		
	Isophorone		<	0.015	ug/g		
	2-Nitrophenol		<	0.033	ug/g		
	2,4-Dimethylphenol		<	0.089	ug/g		
	Benzoic acid		<	3.4	ug/g		
	Bis(2-chloroethoxy) methane		<	0.011	ug/g		
	2,4-Dichlorophenol		<	0.10	ug/g		
	1,2,4-Trichlorobenzene		<	0.0048	ug/g		
	Napthalene		J	0.0096	ug/g		
	4-Chloroaniline		<	0.083	ug/g		
	Hexachlorobutadiene		<	0.0053	ug/g		
	4-Chloro-3-methylphenol		<	0.072	ug/g		
	2-Methylnapthalene		<	0.0067	ug/g		
	Hexachlorocyclopentadiene		<	0.048	ug/g		
	2,4,6-Trichlorophenol		<	0.072	ug/g		
	2,4,5-Trichlorophenol		<	0.064	ug/g		
	2-Chloronapthalene		<	0.0086	ug/g		
	2-Nitroaniline		<	0.056	ug/g		
	Dimethylphthalate		<	0.0082	ug/g		
	Acenaphthylene		<	0.0053	ug/g		
	3-Nitroaniline		<	0.43	ug/g		
	Acenaphthene		<	0.0062	ug/g		
	2,4-Dinitrophenol		<	3.1	ug/g		
	4-Nitrophenol		<	1.7	ug/g		
	Dibenzofuran		<	0.0053	ug/g		
	2,6-Dinitrotoluene		<	0.018	ug/g		
	2,4-Dinitrotoluene		<	0.036	ug/g		
	Diethylphthalate			0.053	ug/g		
	4-Chlorophenyl-phenylether		<	0.0067	ug/g		
	Fluorene		<	0.0077	ug/g		
	4-Nitroaniline		<	0.091	ug/g		
	4,6-Dinitro-2-methylphenol		<	1.5	ug/g		
	N-Nitrosodiphenylamine		<	0.011	ug/g		
	4-Bromophenyl-phenylether		<	0.0077	ug/g		
	Hexachlorobenzene		<	0.0062	ug/g		

Reviewed By:  , Analyst

Approved By: _____

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

SEMI-VOLATILE ORGANIC RESULTS - METHOD 8270

04/05/94

Field Description	Analyte	Dilution Factor		Result	Units	Date Extracted	Date Analyzed
METHOD BLANK	Pentachlorophenol	0.048	<	1.4	ug/g	9/27/93	10/8/93
	Phenanthrene		<	0.0062	ug/g		
	Anthracene		<	0.010	ug/g		
	Di-n-butylphthalate			1.1	ug/g		
	Fluoranthene		<	0.0077	ug/g		
	Pyrene		<	0.0067	ug/g		
	Butylbenzylphthalate		<	0.019	ug/g		
	3,3-Dichlorobenzidine		<	0.024	ug/g		
	Benzo (a) anthracene		<	0.0062	ug/g		
	Bis (2ethylhexyl) phthalate		<	0.030	ug/g		
	Chrysene		<	0.0062	ug/g		
	Di-n-octyl phthalate		<	0.074	ug/g		
	Benzo (b) fluoranthene		<	0.017	ug/g		
	Benzo (k) fluoranthene		<	0.025	ug/g		
	Benzo (a) pyrene		<	0.019	ug/g		
	Indeno (1,2,3-cd) pyrene		<	0.0062	ug/g		
	Dibenz (a,h) anthracene		<	0.0062	ug/g		
	Benzo (g,h,i) perylene		<	0.0062	ug/g		

SURROGATE RECOVERIES:

2-Fluorophenol (25-121)	87	%
Phenol-d6 (24-113)	98	%
Nitrobenzene-d5 (23-120)	87	%
2-Fluorobiphenyl (30-115)	68	%
2,4,6-Tribromophenol (19-122)	96	%
Terphenyl-d14 (18-137)	88	%

Reviewed By:  , AnalystApproved By: 

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

SEMI-VOLATILE ORGANIC RESULTS - METHOD 8270

05-Apr-94

Field Description	Analyte	Dilution Factor	Result	Units	Date Extracted	Date Analyzed
METHOD BLANK	Aniline	1.0	< 0.86	ug/L	9/28/93	10/18/93
	Phenol		< 0.67	ug/L		
	Bis(2-chloroethyl) ether		< 0.25	ug/L		
	2-Chlorophenol		< 0.18	ug/L		
	1,3-Dichlorobenzene		< 0.14	ug/L		
	1,4-Dichlorobenzene		< 0.080	ug/L		
	1,2-Dichlorobenzene		< 0.15	ug/L		
	Benzyl alcohol		< 27	ug/L		
	2-Methylphenol		< 1.4	ug/L		
	Bis(2-chloroisopropyl) ether		< 0.41	ug/L		
	4-Methylphenol		< 0.95	ug/L		
	N-Nitroso-di-n-propylamine		< 0.26	ug/L		
	Hexachloroethane		< 0.15	ug/L		
	Nitrobenzene		< 0.32	ug/L		
	Isophorone		< 0.32	ug/L		
	2-Nitrophenol		< 0.69	ug/L		
	2,4-Dimethylphenol		< 1.9	ug/L		
	Benzoic acid		< 70	ug/L		
	Bis(2-chloroethoxy) methane		< 0.23	ug/L		
	2,4-Dichlorophenol		< 2.2	ug/L		
	1,2,4-Trichlorobenzene		< 0.10	ug/L		
	Napthalene		J 0.12	ug/L		
	4-Chloroaniline		< 1.7	ug/L		
	Hexachlorobutadiene		< 0.11	ug/L		
	4-Chloro-3-methylphenol		< 1.5	ug/L		
	2-Methylnapthalene		< 0.14	ug/L		
	Hexachlorocyclopentadiene		< 0.99	ug/L		
	2,4,6-Trichlorophenol		< 1.5	ug/L		
	2,4,5-Trichlorophenol		< 1.3	ug/L		
	2-Chloronaphthalene		< 0.18	ug/L		
	2-Nitroaniline		< 1.2	ug/L		
	Dimethylphthalate		< 0.17	ug/L		
	Acenaphthylene		< 0.11	ug/L		
	3-Nitroaniline		< 9.0	ug/L		
	Acenaphthene		< 0.13	ug/L		
	2,4-Dinitrophenol		< 65	ug/L		
	4-Nitrophenol		< 35	ug/L		
	Dibenzofuran		< 0.11	ug/L		
	2,6-Dinitrotoluene		< 0.37	ug/L		
	2,4-Dinitrotoluene		< 0.76	ug/L		
	Diethylphthalate		< 0.67	ug/L		
	4-Chlorophenyl-phenylether		< 0.14	ug/L		
	Fluorene		< 0.16	ug/L		
	4-Nitroaniline		< 1.9	ug/L		
	4,6-Dinitro-2-methylphenol		< 31	ug/L		
	N-Nitrosodiphenylamine		< 0.23	ug/L		
	4-Bromophenyl-phenylether		< 0.16	ug/L		
	Hexachlorobenzene		< 0.13	ug/L		

Reviewed By:  , Analyst

Approved By: _____

U.S. ARMY CORPS OF ENGINEERS - ENVIRONMENTAL LABORATORY

SEMI-VOLATILE ORGANIC RESULTS - METHOD 8270

04/05/94

Field Description	Analyte	Dilution Factor	Result	Units	Date Extracted	Date Analyzed
METHOD BLANK	Pentachlorophenol	1.00	< 30	ug/L	9/28/93	10/18/93
	Phenanthrene		< 0.13	ug/L		
	Anthracene		< 0.21	ug/L		
	Di-n-butylphthalate		< 0.41	ug/L		
	Fluoranthene		< 0.16	ug/L		
	Pyrene		< 0.14	ug/L		
	Butylbenzylphthalate		< 0.39	ug/L		
	3,3-Dichlorobenzidine		< 0.51	ug/L		
	Benzo(a)anthracene		< 0.13	ug/L		
	Bis(2ethylhexyl)phthalate		J 0.82	ug/L		
	Chrysene		< 0.13	ug/L		
	Di-n-octyl phthalate		< 1.6	ug/L		
	Benzo(b)fluoranthene		< 0.36	ug/L		
	Benzo(k)fluoranthene		< 0.53	ug/L		
	Benzo(a)pyrene		< 0.40	ug/L		
	Indeno(1,2,3-cd)pyrene		< 0.13	ug/L		
	Dibenz(a,h)anthracene		< 0.13	ug/L		
	Benzo(g,h,i)perylene		< 0.13	ug/L		

SURROGATE RECOVERIES:

2-Fluorophenol (10-94)	80	%
Phenol-d6 (21-100)	58	%
Nitrobenzene-d5 (35-114)	93	%
2-Fluorobiphenyl (43-116)	65	%
2,4,6-Tribromophenol (10-123)	91	%
Terphenyl-d14 (33-141)	90	%

Reviewed By:  , Analyst

Approved By: _____

APPENDIX B

BARRE FALLS DAM
PRIORITY POLLUTANT SCAN
STANDARDS AND DATA SUMMARIES
TABLES 7 - 32

TABLE 7

STANDARDS AND DATA SUMMARY FOR
PCBs

Range at Barre Falls Dam

Sediment - J 0.036 to J 0.042 ppm

Drinking Water Standards

Primary - 0.0005 ppm (proposed)

Secondary - NA

MCLG - NA

Freshwater Aquatic Life Criteria

Acute - NA

Chronic - 0.000014 ppm

Lowest Reported Toxic Concentration

Freshwater

Acute - 0.002 ppm

Chronic - NA

Saltwater

Acute - 0.01 ppm

Chronic - NA

Great Lakes Sediment Guidelines

Nonpolluted - NA

Moderately Polluted - NA

Heavily Polluted - >10 ppm

MA DEQE - DWPC Sediment Classification

Type I - <0.5 ppm

Type II - 0.5-1.0 ppm

Type III - >1.0 ppm

Sediment Management Standards for the State of Washington

Normalized on a Total Organic Carbon (TOC) Basis

Sediment Quality Standards - 12 ppm

Sediment Cleanup Standards - 65 ppm

Assuming sediment TOC concentration is 8.9%

Sediment Quality Standards - 1.068 ppm

Sediment Cleanup Standards - 5.79 ppm

Assuming sediment TOC concentration is 3.4%

Sediment Quality Standards - 0.41 ppm

Sediment Cleanup Standards - 2.21 ppm

Biological Sediment Effects

ER-L - 0.050 ppm

ER-M - 0.40 ppm

AET - NA

Start of Biological Effects - >0.003 ppm

TABLE 7 (CONT'D)
STANDARDS AND DATA SUMMARY FOR
PCBs

Background Concentrations in Soils/Sediments

Pacific Coast to Continental Divide - 0.0022 to 0.020 ppm
Appalachian Mountain-Atlantic Coast - 0.1 to 0.5 ppm

Atmospheric Deposition in South Carolina Marsh Sediment

Mean - 0.0026 ppm

Other NED Projects

Birch Hill Dam, MA (Contaminated Sediments)

Range - <0.0025 to 250 ppm

West Thompson Lake (Contaminated Sediments)

Range - 0.058 to 1.0

Thomaston Dam, CT (Lightly Contaminated Sediments)

Range - 0.068 to 0.27 ppm

Hop Brook Lake, CT (Lightly Contaminated Sediments)

Range - 0.02 to 0.09 ppm

Otter Brook Lake, NH (Clean Sediments)

Range - <0.0043 to 0.017 ppm

Notes:

¹Pollutional classification of sediments is based on their overall condition; these sediments were not necessarily contaminated with PCBs.

TABLE 8

STANDARDS AND DATA SUMMARY FOR
DIOXINS AND FURANS

Barre Falls Dam, Station BF02, Sediment

OctaCDD - <0.016 ppb

Total PCDD - <0.02937 ppb

Total PCDD/PCDF - <0.04137 ppb

Barre Falls Dam, Station BF10, Sediment

OctaCDD - 0.032 ppb

Total PCDD - <0.0463 ppb

Total PCDD/PCDF - <0.05521 ppb

Drinking Water Standards - N/A

Freshwater Aquatic Life Criteria - N/A

Background Concentrations in Soils/Sediments

Most US Soils - < 0.002 ppb TCDD

15 Urban US Soils - 0.05 to 9.1 ppb PCDD/PCDF

Lake Ontario Sediments - 0.003 to 0.013 ppb TCDD

Rural Michigan Soils - < 1 ppb PCDD/PCDF

Lake Huron Sediments - 0.56 to 0.9 ppb PCDD/PCDF

Mean Lake Huron Sediments - 0.87 ppb OCDD

Mean Lake Michigan Sediments - 0.90 ppb OCDD

Lake Zurich Sediments - 1.7 ppb PCDD/PCDF

Contaminated Soils and Sediments

Love Canal, New York, Sewer and Creek Sediment

- 0.9 to 312 ppb TCDD

Horse Arenas Sprayed with Dioxin-Contaminated Oil

- 31,800 to 33,000 ppb TCDD

Times Beach, Missouri, Soil Sprayed with Dioxin-

Contaminated Oil - 0.8 to 196 ppb TCDD

Michigan Soils close to a Chemical Waste Combustion

Source - 3,000 ppb PCDD/PCDF

Maximum Levels at Other NED Projects

Birch Hill Dam, MA (Contaminated Sediments)¹

Contaminated Sediments

HexaCDD - 0.073 ppb

HeptaCDD - 1.5 ppb

OctaCDD - 11 ppb

Total PCDD - 12.6 ppb

HexaCDF - 0.12 ppb

HeptaCDF - 0.059 ppb

OctaCDF - 1.0 ppb

Total PCDF - 1.2 ppb

Total PCDD/PCDF - 13.8 ppb

Background Sediments

OctaCDD - 0.41 ppb

Total PCDD - 0.41 ppb

TABLE 8 (CONT'D)

STANDARDS AND DATA SUMMARY FOR
DIOXINS AND FURANS

Maximum Levels at Other NED Projects (Cont.)

West Thompson Lake, CT (Contaminated Sediments)

Contaminated Sediments

HexaCDD - 0.270 to <.0023 ppb
HeptaCDD - 1.2 to .02 ppb
OctaCDD - 5.2 to .086 ppb
Total PCDD - 6.693 to .1155 ppb
HexaCDF - .33 to <.0043 ppb
HeptaCDF - 0.72 to .0096 ppb
OctaCDF - 0.79 to .016 ppb
Total PCDF - 2.27 to 0.091 ppb
Total PCDD/PCDF - 8.963 to 0.206 ppb

Hop Brook Lake, CT (Lightly Contaminated Sediments)

OctaCDF - 2.9 ppb
Total PCDD - <3.2 ppb
Total PCDD/PCDF - <4 ppb

Thomaston Dam, CT (Lightly Contaminated Sediments)

No Detectable Concentrations

Otter Brook Lake, NH (Clean Sediments)

No Detectable Concentrations

West Hill Dam, MA (Clean Sediments)

No Detectable Concentrations

Notes:

¹Pollutional classification of sediments is based on their overall condition; these sediments were not necessarily contaminated with dioxins or furans.

TABLE 9
STANDARDS AND DATA SUMMARY FOR
Endosulfan I

Range at Barre Falls Dam
Sediment - J3.8 to <4.7 ppb

Drinking Water Standards - NA

Existing Freshwater Aquatic Life Criteria - DDT & metabolites
Acute - 0.22 ppb
Chronic - 0.056 ppb

Biological Sediment Effects
ER-L - NA
ER-M - NA
AET - NA

Range at other NED projects
Contaminated Sediments¹
West Thompson Lake, CT - <1.9 to <5.7 ppb
Lightly Contaminated Sediments
Thomaston Lake, CT - <8.4 to 16 ppb
Clean Sediments
Otter Brook Lake, NH - <3.2 to <3.5 ppb

Notes:

J - Estimated value; analyte detected at less than the Practical Quantitation Limit.

¹Pollutional classification of sediments is based on their overall condition; these sediments were not necessarily contaminated with Endosulfan I.

TABLE 10
STANDARDS AND DATA SUMMARY FOR
4,4'-DDD

Range at Barre Falls Dam
Sediment - 18 to J 5.3 ppb

Drinking Water Standards - NA

Existing Freshwater Aquatic Life Criteria - DDT & metabolites
Acute - 1.1 ppb
Chronic - 0.001 ppb

Proposed Freshwater Aquatic Life Criteria - DDT & metabolites
Acute - 0.021 ppb
Chronic - 0.0067 ppb

Biological Sediment Effects
ER-L - 2 ppb
ER-M - 20 ppb
AET - NA

WQ criteria based on sediment/water partitioning (1% TOC)
Acute - 3,250 ppb

Concentrations in Soils/Sediments

US National Soils Monitoring Program

FY92, 37 states - 10 to 38,460; ave. 50 ppb

FY91, 5 cities - 10 to 6,570; ave. 100 ppb

8 US cities - 10 to 5,060; ave. 120 ppb

STORET Database - 0.2 ppb median conc.

Undisturbed Californian Coastal Sediments

1955 - 12 ppb

1976 - 18 ppb

Lake Michigan Sediments

1970-71 - 0.01 to 12.6; avg. 3.04 ppb

1971 - 0.02 to 5.47; ave. 1.01 ppb

Potomac River Basin Sediments - 0.8 to 640; ave. 104 ppb

Agricultural Areas

US Rice-Growing Areas - 10 to 940; ave. 50 ppb

Japanese Field Soils - 18 to 1,554 ppb

Range at other NED projects

Otter Brook Lake, New Hampshire (Clean Sediments)¹

Sediment - <6.9 to 8 ppb

Thomaston Dam, CT (Lightly Contaminated Sediments)

Sediment - 9.1 to 24 ppb

TABLE 10
STANDARDS AND DATA SUMMARY FOR
4,4'-DDD

Range at other NED projects (Cont.)

Hop Brook Lake, CT (Lightly Contaminated Sediments)

Sediment - J 5.3 to 18 ppb

West Thompson Lake, CT (Contaminated Sediments)

Sediment - 740 to <1.7 ppb

Notes:

J - Estimated value; analyte detected at less than the Practical Quantitation Limit.

¹Pollutional classification of sediments is based on their overall condition; these sediments were not necessarily contaminated with DDD.

TABLE 11

STANDARDS AND DATA SUMMARY FOR
ARSENIC

Range at Barre Falls Dam

Water - <0.0030 ppm

Sediment - 5.4 to 2.4 ppm

Drinking Water Standards

Primary - 0.05 ppm

Secondary - NA

MCLG - 0.05 ppm

Freshwater Aquatic Life Criteria

Acute - 0.36 ppm (Arsenic III)

Chronic - 0.19 ppm (Arsenic III)

Great Lakes Sediment Guidelines

Nonpolluted - <3 ppm

Moderately Polluted - 3 to 8 ppm

Heavily Polluted - >8 ppm

MA DEQE - DWPC Sediment Classification

Type I - <10 ppm

Type II - 10-20 ppm

Type III - >20 ppm

Sediment Management Standards for the State of Washington

Sediment Quality Standards - 57 ppm

Sediment Cleanup Standards - 93 ppm

Biological Sediment Effects

ER-L - 33 ppm

ER-M - 85 ppm

AET - 50 ppm

Concentrations in Soils

Earth's Crust - 1.81 to 6 ppm

Background Concentrations in Michigan Soils

Range - 0.006 to 39 ppm

Mean - 2.5 ppm

Background Concentrations in Ontario Soils

Range - 5.8 to 6.4 ppm

Concentrations in Sediments

Highly Polluted¹

French River, CT - 2.1 to 31.4; mean 16.65 ppm

Ashtabula River, OH - 12 to 56; mean 28.9 ppm

Blackstone River, MA - 3 ppm.

TABLE 11 (CONT'D)

STANDARDS AND DATA SUMMARY FOR
ARSENIC

Concentrations in Sediments (Cont.)

Polluted

Oxoboxo River, CT - 8 to 16; mean 11 ppm
North River, MA - 0.8 ppm
Quinsigamond River, MA - 4.2 ppm

Clean

Oak Orchard Harbor, NY - 2.1 to 5.7; mean 3.2 ppm
Winnepesaukee River, NH - 2.3 to 2.6 ppm
South River, MA - 0.2 ppm
Lake Quinsigamond - 94 ppm

Unclassified

Gulf of Maine Dredged Harbors
Number - 598
Mean - 6.98 ppm
Mean plus 2 standard deviations - 22.3 ppm
Cape Cod to Western Connecticut Dredged Harbors
Number - 598
Mean - 7.3 ppm
Mean plus 2 standard deviations - 24.7 ppm
16 Massachusetts Lakes
Mean 14.1 ppm
Range 0.7 to 43 ppm

Other NED Projects

Birch Hill Dam, MA (Contaminated Sediments)¹
Range - 0.9 to 2.5 ppm
West Thompson Lake, CT (Contaminated Sediments)
Range - 11 to 48 ppm
Thomaston Dam, CT (Lightly Contaminated Sediments)
Range - 1.4 to 1.7 ppm
Hop Brook Lake, CT (Lightly Contaminated Sediments)
Range - 0.88 to 2.2 ppm
Hopkinton Lake, NH (Clean Sediments)
Range - 2.3 to 3.9 ppm
Otter Brook Lake, NH (Clean Sediments)
Range - 0.6 to 0.7 ppm
Mean of all Other NED Projects - 5.6 ppm

Notes:

¹Pollutional classification of sediments is based on their overall condition; these sediments were not necessarily contaminated with arsenic.

TABLE 12
STANDARDS AND DATA SUMMARY FOR
BERYLLIUM

Range at Barre Falls Dam
Water - <0.0003 ppm
Sediment - 4.2 to 0.14 ppm

Drinking Water Standards
Primary - 0.001 ppm (proposed)
Secondary - NA
MCLG - 0 (proposed)

Freshwater Aquatic Life Criteria - NA

Lowest Reported Toxic Concentration
Freshwater
Acute - 0.13 ppm
Chronic - 0.0053 ppm
Saltwater - NA

Great Lakes Sediment Guidelines - NA

Biological Sediment Effects - NA

Concentrations in Soils
Earth's Crust - 50 ppm
Background Concentrations in Michigan Soils
Range - 0.1 to 1.4 ppm
Mean - 0.5 ppm

Concentrations at Other NED Projects
Otter Brook Lake, NH (Clean Sediments)¹
Range - 0.45 to J 0.55 ppm
Mean - 0.50 ppm
Thomaston Dam, CT (Lightly Contaminated Sediments)
Range - 0.56 to 0.78 ppm
Mean - 0.67 ppm
Hop Brook Lake, CT (Lightly Contaminated Sediments)
Range - 0.17 to 1.8 ppm
Mean - 0.99 ppm
West Thompson Lake, CT (Contaminated Sediments)
Range - 1.1 to 2.1 ppm
Mean - 1.5 ppm
Mean at Other NED Projects - 0.91 ppm

Notes: J - Estimated value; analyte detected at less than the Practical Quantitation Limit.

¹Pollutional classification of sediments is based on their overall condition; these sediments were not necessarily contaminated with beryllium.

TABLE 13

STANDARDS AND DATA SUMMARY FOR
CADMIUM

Range at Barre Falls Dam

Water - <0.0026 ppm

Sediment - <0.93 to 0.51 ppm

Drinking Water Standards

Primary - 0.005 ppm

Secondary - NA

MCLG - 0.005 ppm

Freshwater Aquatic Life Criteria

Acute - 0.0006 ppm (hardness = 19 ppm CaCO_3)*

Chronic - 0.0003 ppm (hardness = 19 ppm CaCO_3)

Great Lakes Sediment Guidelines

Nonpolluted - NA

Moderately Polluted - NA

Heavily Polluted - >6 ppm

MA DEQE - DWPC Sediment Classification

Type I - <5 ppm

Type II - 5-10 ppm

Type III - >10 ppm

Sediment Management Standards for the State of Washington

Sediment Quality Standards - 5.1 ppm

Sediment Cleanup Standards - 6.7 ppm

Biological Sediment Effects

ER-L - 5 ppm

ER-M - 9 ppm

AET - 5 ppm

Concentrations in Soils

Earth's Crust - 0.01 to 0.7 ppm

Background Concentrations in Michigan Soils

Range - <0.025 to 4.1 ppm

Mean - 0.9 ppm

Industrial Northwest Indiana Soils

Surficial Samples

Urban Areas - 12.2 ppm

Rural Areas - 0.6 ppm

Samples from 30-36 cm, all samples - 0.1 to 0.2 ppm

TABLE 13 (CONT'D)

STANDARDS AND DATA SUMMARY FOR
CADMIUM

Concentrations in Sediments

Highly Polluted¹

French River, CT - 0.7 to 25; mean 7.35 ppm
Ashtabula River, OH - 5 to 9; mean 6.1 ppm
Blackstone River, MA - median 17; max. 150 ppm

Polluted

Oxoboxo River, CT - <2 to 14; mean 9 ppm
North River, MA - median 0.9; max. 5.5 ppm
Quinsigamond River, MA - median 0.3; max. 0.6 ppm

Clean

Oak Orchard Harbor, NY - 0.6 to 2.4; mean 2.1 ppm
South River, MA - median 0.2; max. 0.3 ppm
Lake Quinsigamond - median 2.9; max. 5.5 ppm

Unclassified

Gulf of Maine Dredged Harbors

Number - 597
Mean - 3.12 ppm
Mean plus 2 standard deviations - 15.6 ppm

Cape Cod to Western Connecticut Dredged Harbors

Number - 601
Mean - 5.9 ppm
Mean plus 2 standard deviations - 26.9 ppm

16 Massachusetts Lakes

Mean - 2.6 ppm
Maximum - 7.1 ppm

Other NED Projects

Birch Hill Dam, MA (Contaminated Sediments)¹

Range - 0.4 to 1.0 ppm
Mean - 0.6 ppm

West Thompson Lake, CT (Contaminated Sediments)

Range - 0.88 to 22 ppm
Mean - 11 ppm

Thomaston Dam, CT (Lightly Contaminated Sediments)

Range - J 1.2 to J 3.6 ppm
Mean - J 2.4 ppm

Hop Brook Lake, CT (Lightly Contaminated Sediments)

Range - <0.5 to 3.4 ppm
Mean - 1.8 ppm

TABLE 13 (CONT'D)

STANDARDS AND DATA SUMMARY FOR
CADMIUM

Other NED Projects (Cont.)

Hopkinton Lake, NH (Clean Sediments)

Range - <2 ppm

Mean - 3 ppm

Otter Brook Lake, NH (Clean Sediments)

Range - J 0.43 to J 1.2 ppm

Mean - J 0.82 ppm

Mean at all Other NED Projects - 3.34 ppm

Notes:

*Historical average hardness in Ware River at Barre Falls Dam is 19 ppm as CaCO_3 .

J - Estimated value; analyte detected at less than the Practical Quantitation Limit.

¹Pollutional classification of sediments is based on their overall condition; these sediments were not necessarily contaminated with cadmium.

TABLE 14
STANDARDS AND DATA SUMMARY FOR
CHROMIUM

Range at Barre Falls Dam
Water - <0.011 ppm
Sediment - 16 to 8.2 ppm

Drinking Water Standards
Primary - 0.05 ppm
Secondary - NA
MCLG - 0.12 (proposed)

Freshwater Aquatic Life Criteria
Chromium(VI)
Acute - 0.011 ppm
Chronic - 0.016 ppm
Chromium(III)
Acute - 0.053 ppm (hardness = 19 ppm CaCO₃)
Chronic - 0.45 ppm (hardness = 19 ppm CaCO₃)

Great Lakes Sediment Guidelines
Nonpolluted - <25 ppm
Moderately Polluted - 25 to 75 ppm
Heavily Polluted - >75 ppm

MA DEQE - DWPC Sediment Classification
Type I - <100 ppm
Type II - 100-300 ppm
Type III - >300 ppm

Sediment Management Standards for the State of Washington
Sediment Quality Standards - 260 ppm
Sediment Cleanup Standards - 270 ppm

Biological Sediment Effects
ER-L - 80 ppm
ER-M - 145 ppm
AET - NA

Concentrations in Soils
Earth's Crust - 5 to 3,000 ppm
Range in US soils - 1 to 1,500 ppm
Background Concentrations in Michigan Soils
Range - 0.56 to 58 ppm
Mean - 11.8 ppm
Average Concentration in Shale - 100 ppm

TABLE 14 (CONT'D)

STANDARDS AND DATA SUMMARY FOR
CHROMIUM

Concentrations in Sediments

Highly Polluted¹

French River, CT - 23 to 4,710; mean 1,370 ppm
Ashtabula River, OH - 64 to 69; mean 312 ppm
Blackstone River, MA - median 130, max. 900 ppm

Polluted

Oxoboxo River, CT - 34 to 83; mean 61.6 ppm
North River, MA - median 9.8, max. 363 ppm
Quinsigamond River, MA - median 16, max. 40 ppm

Clean

Oak Orchard Harbor, NY - 6.4 to 12; mean 9.0 ppm
Winnepesaukee River, NH - 12 to 13 ppm
South River, MA - median 6.2, max. 7.5 ppm
Lake Quinsigamond - median 34, max. 73 ppm

Unclassified

Gulf of Maine Dredged Harbors

Number - 597
Mean - 112 ppm
Mean plus 2 standard deviations - 563 ppm

Cape Cod to Western Connecticut Dredged Harbors

Number - 598
Mean - 160 ppm
Mean plus 2 standard deviations - 783 ppm

16 Massachusetts Lakes

Mean - 36 ppm
Range - 5 to 150 ppm

Other NED Projects

Birch Hill Dam, MA (Contaminated Sediments)¹

Range - 4.4 to 24.9 ppm
Mean - 10.3 ppm

West Thompson Lake, CT (Contaminated Sediments)

Range - 54 to 320 ppm
Mean - 178 ppm

Thomaston Dam, CT (Lightly Contaminated Sediments)

Range - 26 to 52 ppm
Mean - 39 ppm

Hop Brook Lake, CT (Lightly Contaminated Sediments)

Range - J 4.6 to 48 ppm
Mean - 3.2 ppm

TABLE 14 (CONT'D)
STANDARDS AND DATA SUMMARY FOR
CHROMIUM

Other NED Projects (Cont.)
Hopkinton Lake, NH (Clean Sediments)
Range - 22 to 32 ppm
Mean - 27 ppm
Otter Brook Lake, NH (Clean Sediments)
Range - 16 to 40 ppm
Mean - 28 ppm
Mean at all Other NED Projects - 48 ppm

Notes:

J - Estimated value; analyte detected at less than the Practical Quantitation Limit.

¹Pollutional classification of sediments is based on their overall condition; these sediments were not necessarily contaminated with chromium.

TABLE 15

STANDARDS AND DATA SUMMARY FOR
COPPER

Range at Barre Falls Dam
Water - < 0.0048 ppm
Sediment - 11 to 4.8 ppm

Drinking Water Standards
Primary - NA
Secondary - 1 ppm (proposed)
MCLG - 1.3 ppm

Freshwater Aquatic Life Criteria
Acute - 0.0092 ppm
Chronic - 0.0065 ppm

Great Lakes Sediment Guidelines
Nonpolluted - <25 ppm
Moderately Polluted - 25 to 50 ppm
Heavily Polluted - >50 ppm

MA DEQE - DWPC Sediment Classification
Type I - <200 ppm
Type II - 200-400 ppm
Type III - >400 ppm

Sediment Management Standards for the State of Washington
Sediment Quality Standards -390 ppm
Sediment Cleanup Standards - 390 ppm

Biological Sediment Effects
ER-L - 70 ppm
ER-M - 390 ppm
AET - 300 ppm

Concentrations in Soils
Earth's Crust - 2 to 100 ppm
Background Concentrations in Michigan Soils
Range - <0.1 to 74 ppm
Mean - 12.6 ppm
Concentrations in Ontario Agricultural Soils
Range - 20 to 65 ppm
Mean - 65 ppm
Industrial Northwest Indiana Soils
Surficial Samples
Urban Areas - 212 ppm
Rural Areas - 75 ppm
Samples from 30-36 cm, all samples 1.5 to 3.7 - ppm

TABLE 15 (CONT'D)

STANDARDS AND DATA SUMMARY FOR
COPPER

Concentrations in Soils (Cont'd)

Concentrations in Ontario Agricultural Soils

Range - 20 to 65 ppm

Mean - 65 ppm

Industrial Northwest Indiana Soils

Surficial Samples

Urban Areas - 212 ppm

Rural Areas - 75 ppm

Samples from 30-36 cm, all samples 1.5 to 3.7 - ppm

Concentrations in Sediments

Highly Polluted¹

French River, CT - 5 to 1,790; mean 541 ppm

Ashtabula River, OH - 34 to 69; mean 48.7 ppm

Blackstone River, MA - median 320, max. 1,850 ppm

Polluted

Oxoboxo River, CT - 170 to 350; mean 275 ppm

North River, MA - median 15, max. 635 ppm

Quinsigamond River, MA - median 13, max. 21 ppm

Clean

Oak Orchard Harbor, NY - 13 to 80; mean 23 ppm

Winnepesaukee River, NH - 13 to 15 ppm

South River, MA - median 6, max. 8.4 ppm

Lake Quinsigamond - median 94, max. 180 ppm

Unclassified

Gulf of Maine Dredged Harbors

Number - 591

Mean - 83 ppm

Mean plus 2 standard deviations - 342 ppm

Cape Cod to Western Connecticut Dredged Harbors

Number - 601

Mean - 260 ppm

Mean plus 2 standard deviations - 1,330 ppm

16 Massachusetts Lakes

Mean - 284 ppm

Range - 20 to 940 ppm

Other NED Projects

Birch Hill Dam, MA (Contaminated Sediments)

Range - 6.4 to 40.5 ppm

Mean - 24.5 ppm

West Thompson Lake, CT (Contaminated Sediments)

Range - 30 to 170 ppm

Mean - 116. ppm

TABLE 15 (CONT'D)

SUMMARY AND DATA STANDARDS FOR
COPPER

Other NED Projects (Cont'd)

Thomaston Dam, CT (Lightly Contaminated Sediments)

Range - 51 to 110 ppm

Mean - 80 ppm

Hop Brook Lake, CT (Lightly Contaminated Sediments)

Range - 13 to 39 ppm

Mean - 26 ppm

Otter Brook Lake, NH (Clean Sediments)

Range - 3.6 to 13 ppm

Mean - 8.4 ppm

Hopkinton Lake, NH (Clean Sediments)

Range - 25 to 25.5 ppm

Mean - 25.25 ppm

Mean at all Other NED Projects - 45 ppm

Notes:

J - Estimated value; analyte detected at less than the
Practical Quantitation Limit.

¹Pollutional classification of sediments is based on their
overall condition; these sediments were not necessarily
contaminated with copper.

TABLE 16

STANDARDS AND DATA SUMMARY FOR
LEAD

Range at Barre Falls Dam

Water - <0.0030 ppm

Sediment - 28 to 21 ppm

Drinking Water Standards

Primary - None (formerly 0.050 ppm)

Secondary - NA

MCLG - 0

Freshwater Aquatic Life Criteria

Acute - 0.0099 ppm (hardness = 19 ppm CaCO_3)

Chronic - 0.00038 ppm (hardness = 19 ppm CaCO_3)

Great Lakes Sediment Guidelines

Nonpolluted - <40 ppm

Moderately Polluted - 40 to 60 ppm

Heavily Polluted - >60 ppm

MA DEQE - DWPC Sediment Classification

Type I - <100 ppm

Type II - 100-200 ppm

Type III - >200 ppm

Sediment Management Standards for the State of Washington

Sediment Quality Standards - 450 ppm

Sediment Cleanup Standards - 530 ppm

Biological Sediment Effects

ER-L - 35 ppm

ER-M - 110 ppm

AET - 300 ppm

Concentrations in Soils

Earth's Crust - 10 to 16 ppm

Average Abundance in Shale - 20 ppm

Lead in US Soils

Range - 10 to 700 ppm

Mean - 16 ppm

Northeastern USA Forest Soils

1980 - mean 146.3 ppm

1990 - mean 121.3 ppm

TABLE 16 (CONT'D)

STANDARDS AND DATA SUMMARY FOR
LEAD

Concentrations in Soils (Cont'd)

Industrial Northwest Indiana Soils

Surficial Samples

Urban Areas - 755 ppm

Rural Areas - 163 ppm

Samples from 30-36 cm, all samples - 0.2 to 0.9 ppm

Background Concentrations in Michigan Soils

Sandy Soils - <0.5 to 140; mean 9.8 ppm

Silty Soils - <2.5 to 28; mean 7.1 ppm

Clayey Soils - <0.5 to 90; mean 14 ppm

Overall - <0.5 to 140; mean - 10.3 ppm

Concentrations in Sediments

Highly Polluted¹

French River, CT - 13 to 840; mean 358 ppm

Ashtabula River, OH - 38 to 89; mean 63.5 ppm

Blackstone River, MA - median 200, max. 980 ppm

Polluted

Oxoboxo River, CT - 12 to 340; mean 187 ppm

North River, MA - median 50, max. 300 ppm

Quinsigamond River, MA - median 45, max. 120 ppm

Clean

Oak Orchard Harbor, NY - 6.4 to 34; mean 13.9 ppm

Winnepesaukee River, NH - 88 to 93 ppm

South River, MA - median 18, max. 50 ppm

Lake Quinsigamond - median 265, max. 400 ppm

Unclassified

Gulf of Maine Dredged Harbors

Number - 598

Mean - 83 ppm

Mean plus 2 standard deviations - 285 ppm

Cape Cod to Western Connecticut Dredged Harbors

Number - 601

Mean - 145 ppm

Mean plus 2 standard deviations - 711 ppm

16 Massachusetts Lakes

Mean - 274 ppm

Range - 72 to 970 ppm

Other NED Projects

Birch Hill Dam, MA (Contaminated Sediments)¹

Range - 22.1 to 78.6 ppm

Mean - 46.3 ppm

West Thompson Lake, CT (Contaminated Sediments)¹

Range - 68 to 1500 ppm

Mean - 639 ppm

Thomaston Dam, CT (Lightly Contaminated Sediments)

Range - 37 to 86 ppm

Mean - 62 ppm

TABLE 16
(Continued)

STANDARDS AND DATA SUMMARY FOR
LEAD

Other NED Projects (Cont.)

Hop Brook Lake CT (Lightly Contaminated Sediments)

Range - 16 to 58 ppm

Mean - 37 ppm

Otter Brook Lake, NH (Clean Sediments)

Range - 8.2 to 16 ppm

Mean - 8.1 ppm

Hopkinton Lake, NH (Clean Sediments)

Range - 65.8 to 73.4 ppm

Mean - 69.6 ppm

Mean of all Other NED Projects - 144 ppm

¹Pollutional classification of sediments is based on their overall condition; these sediments were not necessarily contaminated with lead.

TABLE 17

STANDARDS AND DATA SUMMARY FOR
NICKEL

Range at Barre Falls Dam

Water - <0.0084 ppm

Sediment - 14 to 4.8 ppm

Drinking Water Standards

Primary - 0.1 (proposed)

Secondary - NA

MCLG - 0.1 ppm (proposed)

Freshwater Aquatic Life Criteria

Acute - 0.35 ppm (hardness = 19 ppm CaCO_3)

Chronic - 0.039 ppm (hardness = 19 ppm CaCO_3)

Great Lakes Sediment Guidelines

Nonpolluted - <20 ppm

Moderately Polluted - 20 to 50 ppm

Heavily Polluted - >50 ppm

MA DEQE - DWPC Sediment Classification

Type I - <50 ppm

Type II - 50-100 ppm

Type III - >100 ppm

Biological Sediment Effects

ER-L - 30 ppm

ER-M - 50 ppm

AET - NA

Concentrations in Soils

Earth's Crust - 15 to 80 ppm

US Soils

Range - 45 to 70 ppm

Mean - 20 ppm

Background Concentrations in Michigan Soils

Range - <0.25 to 53 ppm

Mean - 14.2 ppm

Concentrations in Sediments

Highly Polluted¹

French River, CT - 9.9 to 50.9; mean 28.5 ppm

Ashtabula River, OH - 28 to 63; mean 44.1 ppm

Blackstone River, MA - median 68, max. 320 ppm

Polluted

Oxoboxo River, CT - 20 to 40; mean 30 ppm

North River, MA - median 8.1, max. 32 ppm

Quinsigamond River, MA - median 16, max. 64 ppm

TABLE 17
(Continued)

STANDARDS AND DATA SUMMARY FOR
NICKEL

Concentrations in Sediments

Clean

Oak Orchard Harbor, NY - 14 to 20; mean 18 ppm

South River, MA - median 3.6, max. 4.2 ppm

Lake Quinsigamond - median 46, max. 48 ppm

Unclassified

Gulf of Maine Dredged Harbors

Number - 598

Mean - 36 ppm

Mean plus 2 standard deviations - 92 ppm

Cape Cod to Western Connecticut Dredged Harbors

Number - 600

Mean - 49 ppm

Mean plus 2 standard deviations - 139 ppm

16 Massachusetts Lakes

Mean - 56 ppm

Range - 20 to 201 ppm

Other NED Projects

Birch Hill Dam, MA (Contaminated Sediments)

Range - 5 to 12.3 ppm

Mean - 9 ppm

West Thompson Lake, CT (Contaminated Sediments)

Range - 10 to 56 ppm

Mean - 40 ppm

Thomaston Dam, CT (Lightly Contaminated Sediments)

Range - J 31 to J 38 ppm

Mean - 34 ppm

Hop Brook Lake, CT (Lightly Contaminated Sediments)

Range - J 5.1 to J 31 ppm

Mean - 18 ppm

Otter Brook Lake, NH (Clean Sediments)

Range - J 7.2 to J 26 ppm

Mean - 17 ppm

Hopkinton Lake, NH (Clean Sediments)

Range - 11 to 15 ppm

Mean - 13 ppm

Mean for all Other NED Projects - 23 ppm

Notes: J - Estimated value; analyte detected at less than the Practical Quantitation Limit.

¹Pollutional classification of sediments is based on their overall condition; these sediments were not necessarily contaminated with nickel.

TABLE 18

STANDARDS AND DATA SUMMARY FOR
SELENIUM

Range at Barre Falls Dam

Water - <0.0030 ppm

Sediment - J1.5 to J0.68 ppm

Drinking Water Standards

Primary - 0.05 ppm

Secondary - NA

MCLG - 0.05 ppm

Freshwater Aquatic Life Criteria

Acute - 0.020 ppm

Chronic - 0.0051 ppm

Great Lakes Sediment Guidelines

Nonpolluted - NA

Moderately Polluted - NA

Heavily Polluted - NA

Sediment Management Standards for the State of Washington

Sediment Quality Standards - NA

Sediment Cleanup Standards - NA

Biological Sediment Effects

ER-L - NA

ER-M - NA

AET - NA

Other NED Projects

Contaminated Sediments¹

West Thompson Lake, CT - J0.29 to J0.90 ppm

Lightly Contaminated Sediments

Thomaston Dam, CT - <0.50 ppm

Hop Brook Lake, CT - <0.50 ppm

Clean Sediments

Otter Brook Lake, CT - <0.005 ppm

Notes:

J - Estimated value; analyte detected at less than the
Practical Quantitation Limit.

¹Pollutional classification of sediments is based on their
overall condition; these sediments were not necessarily
contaminated with selenium.

TABLE 19
STANDARDS AND DATA SUMMARY FOR
THALLIUM

Range at Barre Falls Dam
Water - <0.0045 ppm
Sediment - <0.51 to J0.51 ppm

Drinking Water Standards
Primary - 0.002 ppm
Secondary - NA
MCLG - 0.002 ppm

Freshwater Aquatic Life Criteria
Acute - 1.4 ppm (hardness = 19 ppm CaCO_3)
Chronic - 0.04 ppm (hardness = 19 ppm CaCO_3)

Great Lakes Sediment Guidelines
Nonpolluted - NA
Moderately Polluted - NA
Heavily Polluted - NA

Sediment Management Standards for the State of Washington
Sediment Quality Standards - NA
Sediment Cleanup Standards - NA

Biological Sediment Effects
ER-L - NA
ER-M - NA
AET - NA

Other NED Projects
Thomaston Dam, CT (Lightly Contaminated Sediments¹)
Range - <0.50 ppm
Mean - 0.50 ppm
Otter Brook Lake, CT (Clean Sediments)
Range - <0.005 ppm
Mean - 0.005 ppm
Overall Mean - 0.505 ppm

Notes:

J - Estimated value; analyte detected at less than the Practical Quantitation Limit.

¹Pollutional classification of sediments is based on their overall condition; these sediments were not necessarily contaminated with thallium.

TABLE 20

STANDARDS AND DATA SUMMARY FOR
ZINC

Range at Barre Falls Dam

Water - 0.026 to 0.015 ppm

Sediment - 63 to 29 ppm

Drinking Water Standards

Primary - NA

Secondary - 5 ppm (proposed)

MCLG - NA

Freshwater Aquatic Life Criteria

Acute - 0.029 ppm (hardness = 19 ppm CaCO_3)*

Chronic - 0.026 ppm (hardness = 19 ppm CaCO_3)

Great Lakes Sediment Guidelines

Nonpolluted - <90 ppm

Moderately Polluted - 90 to 200 ppm

Heavily Polluted - >200 ppm

MA DEQE - DWPC Sediment Classification

Type I - <200 ppm

Type II - 200-400 ppm

Type III - >400 ppm

Sediment Management Standards for the State of Washington

Sediment Quality Standards - 410 ppm

Sediment Cleanup Standards - 960 ppm

Biological Sediment Effects

ER-L - 120 ppm

ER-M - 270 ppm

AET - 260 ppm

Concentrations in Soils

Earth's Crust - 5 to 200 ppm

Background Concentrations in Michigan Soils

Sandy Soils - range <2.5 to 150; mean 28 ppm

Silty Soils - range 10 to 79; mean 33 ppm

Clayey Soils - range <0.40 to 150; mean 44 ppm

Overall Mean - 35 ppm

Industrial Northwestern Indiana Forest Soils

Surficial

Urban Areas - 2,977 ppm

Rural Areas - 476 ppm

Samples from 30-36 cm, all samples - 8 to 27 ppm

TABLE 20
(Continued)

STANDARDS AND DATA SUMMARY FOR
ZINC

Concentrations in Sediments

Highly Polluted¹

Ashtabula River, OH - 157 to 604 ppm

Blackstone River, MA - 88 to 4,000, median 480

Polluted

Oxoboxo River, CT - 230 to 3,000 ppm

North River, MA - 9 to 985; median 57 ppm

Quinsigamond River, MA - 48 to 92; median 47 ppm

Clean

Oak Orchard Harbor, NY - 51 to 150; mean 82 ppm

Winnepesaukee River, NH - 171 to 199 ppm

South River, MA - 11 to 17; median 16 ppm

Lake Quinsigamond - 130 to 730; median 410 ppm

Unclassified

Gulf of Maine Dredged Harbors

Number - 598

Mean - 134 ppm

Mean plus 2 standard deviations - 436 ppm

Cape Cod to Western Connecticut Dredged Harbors

Number - 601

Mean - 283 ppm

Mean plus 2 standard deviations - 1,010 ppm

Merrimack River - 23 to 27 ppm

Other NED Projects

West Thompson Lake, CT (Contaminated Sediments)¹

Range - 83 to 1200 ppm

Mean - 548 ppm

Thomaston Dam, CT (Lightly Contaminated Sediments)

Range - 140 to 280 ppm

Mean - 210 ppm

Hop Brook Lake, CT (Lightly Contaminated Sediments)

Range - 33 to 280 ppm

Mean - 156 ppm

Otter Brook Lake, CT (Clean Sediments)

Range - 29 to 85 ppm

Mean - 57 ppm

Mean at all Other NED Projects - 243 ppm

Notes:

*Historical average hardness in Ware River at Barre Falls Dam is 19 ppm as CaCO₃.

¹Pollutional classification of sediments is based on their overall condition; these sediments were not necessarily contaminated with zinc.

TABLE 21

STANDARDS AND DATA SUMMARY FOR
2-BUTANONE (MEK)

Range at Barre Falls Dam
Water - <0.0016 ppm
Sediment - 0.033 to 0.18 ppm

Drinking Water Standards
Primary - NA
Secondary - NA

Freshwater Aquatic Life Criteria - NA

Lowest Effects Concentration - NA

Biological Sediment Effects - NA

Washington State Sediment Management Standards - NA

Other NED Projects
Clean Sediments¹
Otter Brook Lake, NH - ND
Lightly Contaminated Sediments
Thomaston Dam, CT - J 0.035 ppm
Hop Brook Lake, CT - <0.089 to >0.472 ppm
Contaminated Sediments
West Thompson Lake, CT
Range - 0.0098 to 0.160 ppm
Mean - 0.067 ppm

Notes:

J - Estimated value; analyte detected at less than the
Practical Quantitation Limit.

ND - Not detected

¹Pollutional classification of sediments is based on their
overall condition; these sediments were not necessarily
contaminated with 2-Butanone.

TABLE 22

STANDARDS AND DATA SUMMARY FOR
BENZO(A)ANTHRACENE

Range at Hop Brook Lake

Water - <0.00015 to <0.00014 ppm

Sediment - <0.081 to J 0.065 ppm

Drinking Water Standards

Primary - NA

Secondary - NA

MCLG - 0.0002 ppm (proposed)

Freshwater Aquatic Life Criteria - NA

Lowest Effects Concentration

Freshwater - NA

Marine

Acute - 0.3 ppm

Chronic - NA

Biological Sediment Effects

ER-L - 0.23 ppm

ER-M - 1.6 ppm

AET - 0.55 ppm

Sediment Management Standards for the State of Washington

Normalized on a Total Organic Carbon (TOC) Basis

Sediment Quality Standards - 110 ppm

Sediment Cleanup Standards - 270 ppm

Assuming sediment TOC concentration is 8.9%

Sediment Quality Standards - 9.8 ppm

Sediment Cleanup Standards - 24 ppm

Assuming sediment TOC concentration is 3.4%

Sediment Quality Standards - 3.7 ppm

Sediment Cleanup Standards - 9.2 ppm

Concentrations in Soils/Sediments

Remote Adirondack Lakes - 0.078 to 0.36 ppm

Highway soils - 1.5 ppm

Soil contaminated with coal-tar pitch - 2.5 ppm

Buzzards Bay 0.15 miles from shore - 0.33 ppm

Buzzards Bay 1.3 miles from shore - 0.041 ppm

Atlantic Ocean Shelf - 0.0061 ppm

TABLE 22
(Continued)

STANDARDS AND DATA SUMMARY FOR
BENZO(A)ANTHRACENE

Other NED Projects

Contaminated Sediments¹

West Thompson Lake, CT - 0.46 to 1.4 ppm

Lightly Contaminated Sediments

Thomaston Dam, CT - 0.68 to 1.6 ppm

Hop Brook Lake, CT - 0.15 to 0.42 ppm

Clean Sediments

Otter Brook Lake, NH - J 0.028 to 0.18 ppm

Overall Mean at Other NED Projects - 0.62 ppm

Notes:

J - Estimated value; analyte detected at less than the
Practical Quantitation Limit.

¹Pollutional classification of sediments is based on their
overall condition; these sediments were not necessarily
contaminated with benzo(a)anthracene.

TABLE 23

STANDARDS AND DATA SUMMARY FOR
CHRYSENE

Range at Barre Falls Dam

Water - <0.00015 to <0.00014 ppm

Sediment - <0.081 to J 0.053 ppm

Drinking Water Standards

Primary - NA

Secondary - NA

MCLG - 0.0002 ppm (proposed)

Freshwater Aquatic Life Criteria - NA

Lowest Effects Concentration

Freshwater - NA

Marine

Acute - 0.3 ppm

Chronic - NA

CT DEP Freshwater Human Health Criteria

Consumption of Organisms only - 0.000031 ppm

Consumption of Water and Organisms - 0.0000028 ppm

Biological Sediment Effects

ER-L - 0.40 ppm

ER-M - 2.8 ppm

AET - 0.90 ppm

Sediment Management Standards for the State of Washington

Normalized on a Total Organic Carbon (TOC) Basis

Sediment Quality Standards - 110 ppm

Sediment Cleanup Standards - 460 ppm

Assuming sediment TOC concentration is 8.9%

Sediment Quality Standards - 9.8 ppm

Sediment Cleanup Standards - 41 ppm

Assuming sediment TOC concentration is 3.4%

Sediment Quality Standards - 3.7 ppm

Sediment Cleanup Standards - 16 ppm

Concentrations in Soils/Sediments

Remote Adirondack Lakes - 0.19 to 0.89 ppm

Wilderness Lake, Ontario - 0.023 ppm

Australian Great Barrier Reef - <0.0006 to 1.5 ppm

Buzzards Bay 0.5 miles from shore - 0.24 ppm

Buzzards Bay 1.3 miles from shore - 0.04 ppm

Charles River Basin, Boston - 21 ppm

TABLE 23
(Continued)

STANDARDS AND DATA SUMMARY FOR
CHRYSENE

Other NED Projects

Contaminated Sediments¹

West Thompson Lake, CT - 0.71 to 2.0 ppm

Lightly Contaminated Sediments

Thomaston Dam, CT - 0.88 to 1.9 ppm

Hop Brook Lake, CT - 0.22 to 0.63 ppm

Clean Sediments

Otter Brook Lake, NH - J 0.030 to 0.22 ppm

Overall Mean at Other NED Projects - 1.15 ppm

Notes:

J - Estimated value; analyte detected at less than the
Practical Quantitation Limit.

¹Pollutional classification of sediments is based on their
overall condition; these sediments were not necessarily
contaminated with chrysene.

TABLE 24
STANDARDS AND DATA SUMMARY FOR
FLUORANTHENE

Range at Barre Falls Dam

Water - <0.00018 to <0.00017 ppm
Sediment - <0.10 to J 0.12 ppm

Drinking Water Standards - NA

Freshwater Aquatic Life Criteria

Acute - 3.98 ppm
Chronic - NA

Biological Sediment Effects

ER-L - 0.60 ppm
ER-M - 3.6 ppm
AET - 1.0 ppm

Sediment Management Standards for the State of Washington

Normalized on a Total Organic Carbon (TOC) Basis

Sediment Quality Standards - 160 ppm
Sediment Cleanup Standards - 1200 ppm

Assuming sediment TOC concentration is 8.9%

Sediment Quality Standards - 14 ppm
Sediment Cleanup Standards - 107 ppm

Assuming sediment TOC concentration is 3.4%

Sediment Quality Standards - 5.4 ppm
Sediment Cleanup Standards - 41 ppm

Concentrations in Soils/Sediments

Dungeness Bay, Washington - 0.0075 to 0.024 ppm
Remote areas of South America, Africa, and Pacific
Atolls - 0 to 0.0098 ppm.

Buzzards Bay - 0.00011 to 0.00079 ppm

Charles River, MA - 0.019 to 13 ppm

Concentrations in Norwegian Soils

Unpolluted Soils - mean 0.0223 ppm
Unpolluted Bog Soils - mean 0.0832 ppm
Soils Polluted by Total PAH - mean 0.573 ppm

Other NED Projects

Contaminated Sediments¹

West Thompson Lake, CT - 0.87 to 3.2 ppm

Lightly Contaminated Sediments

Thomaston Dam, CT - 1.8 to 3.0 ppm

Hop Brook Lake, CT - 0.24 to 0.99 ppm

Clean Sediments

Otter Brook Lake, NH - J 0.070 to 0.50 ppm

Mean for all Other NED Projects - 1.8 ppm

Notes: J - Estimated value; analyte detected at less than the Practical Quantitation Limit.

¹Pollutional classification of sediments is based on their overall condition; these sediments were not necessarily contaminated with fluoranthene.

TABLE 25

STANDARDS AND DATA SUMMARY FOR
NAPHTHALENE

Range at Barre Falls Dam

Water - <0.000074 to J0.00014; Blank - J0.0096 ppm

Sediment - 0.18 to 0.10; Blank - J0.12 ppm

Drinking Water Standards - NA

Freshwater Aquatic Life Criteria - NA

Lowest Observed Effect Concentration

Freshwater

Acute - 2.3 ppm

Chronic 0.62 ppm

Marine

Acute - 2.3 ppm

Chronic - NA

Biological Sediment Effects

ER-L - 0.34 ppm

ER-M - 2.1 ppm

AET - 0.50 ppm

Sediment Management Standards for the State of Washington

Normalized on a Total Organic Carbon (TOC) Basis

Sediment Quality Standards - 99 ppm

Sediment Cleanup Standards - 170 ppm

Assuming sediment TOC concentration is 8.9%

Sediment Quality Standards - 8.8 ppm

Sediment Cleanup Standards - 15 ppm

Assuming sediment TOC concentration is 3.4%

Sediment Quality Standards - 3.4 ppm

Sediment Cleanup Standards - 5.8 ppm

Concentrations in Soils/Sediments

Unpolluted

Casco Bay, Maine, Sediments - max. 0.113 ppm

Norwegian Soils - mean 0.0463 ppm

Norwegian Bog Soils - mean 0.0577 ppm

Polluted

Norwegian Soils Contaminated by Total PAH

mean - 0.0483 ppm

Buzzards Bay, MA, Sediments

After Oct. 1974 Oil Spill

Oct. 1974 - 9.2 ppm

May 1975 - 0.63 ppm

June 1977 - 0.22 ppm

TABLE 25
(Continued)

STANDARDS AND DATA SUMMARY FOR
NAPHTHALENE

Other NED Projects

Contaminated Sediments¹

West Thompson Lake, CT - J0.13 to J0.32 ppm

Lightly Contaminated Sediments

Thomaston Dam, CT - J0.030 to J0.052 ppm

Hop Brook Lake CT - J0.014 to J0.030 ppm

Clean Sediments

Otter Brook Lake, NH - <0.051 to J0.014 ppm

Mean All Other NED Projects - .072 ppm

Notes:

J - Estimated value; analyte detected at less than the
Practical Quantitation Limit.

¹Pollutional classification of sediments is based on their
overall condition; these sediments were not necessarily
contaminated with naphthalene.

TABLE 26

STANDARDS AND DATA SUMMARY FOR
PHENANTHRENE

Range at Barre Falls Dam

Water - <0.00015 to <0.00014 ppm

Sediment - J 0.12 to J 0.11 ppm

Drinking Water Standards - NA

Freshwater Aquatic Life Criteria

Acute - 0.030 ppm

Chronic - 0.0063 ppm

Biological Sediment Effects

ER-L - 0.225 ppm

ER-M - 1.38 ppm

AET - 0.26 ppm

Sediment Management Standards for the State of Washington

Normalized on a Total Organic Carbon (TOC) Basis

Sediment Quality Standards - 100 ppm

Sediment Cleanup Standards - 480 ppm

Assuming sediment TOC concentration is 8.9%

Sediment Quality Standards - 8.9 ppm

Sediment Cleanup Standards - 43 ppm

Assuming sediment TOC concentration is 3.4%

Sediment Quality Standards - 3.4 ppm

Sediment Cleanup Standards - 16 ppm

Concentrations in Sediments

New York Lakes - 0.015 to 0.32 ppm

Concentrations in Norwegian Soils

Unpolluted Soils - mean 0.030 ppm

Unpolluted Bog Soils - mean 0.0777 ppm

Soils Polluted by Total PAH - mean 0.353 ppm

Concentrations in Soil/Sediments of Phenanthracene Plus Anthracene

Boston Harbor - 3 ppm

Maine - 0.063 ppm

Stoneham, MA (urban soil) - 0.12 ppm

Nova Scotia - 0.001 to 100 ppm

Wyoming - 0.0048 to 0.03 ppm

Alaska - 0.0025 to 0.067 ppm

Hawaii - 0.0036 ppm

Samoa - 0.0003 ppm

TABLE 26
(Continued)

STANDARDS AND DATA SUMMARY FOR
PHENANTHRENE

Other NED Projects

Contaminated Sediments¹

West Thompson Lake, CT - 0.62 to 1.5 ppm

Lightly Contaminated Sediments

Thomaston Dam, CT - 1.2 to 1.9 ppm

Hop Brook Lake, CT - 0.30 to 0.59 ppm

Clean Sediments

Otter Brook Lake, NH - J 0.056 to 0.39 ppm

Mean All Other NED Projects - 1.4 ppm

Notes:

J - Estimated value; analyte detected at less than the
Practical Quantitation Limit.

¹Pollutional classification of sediments is based on their
overall condition; these sediments were not necessarily
contaminated with phenanthrene.

TABLE 27

STANDARDS AND DATA SUMMARY FOR
PYRENE

Range at Barre Falls Dam

Water - <0.00015 to <0.00016 ppm

Sediment - <0.087 to 0.10 ppm

Drinking Water Standards - NA

Freshwater Aquatic Life Criteria NA

Lowest Effects Concentration

Freshwater - NA

Marine

Acute - 0.3 ppm

Chronic - NA

Biological Sediment Effects

ER-L - 0.35 ppm

ER-M - 2.2 ppm

AET - 1.0 ppm

Sediment Management Standards for the State of Washington

Normalized on a Total Organic Carbon (TOC) Basis

Sediment Quality Standards - 1000 ppm

Sediment Cleanup Standards - 1400 ppm

Assuming sediment TOC concentration is 8.9%

Sediment Quality Standards - 89 ppm

Sediment Cleanup Standards - 125 ppm

Assuming sediment TOC concentration is 3.4%

Sediment Quality Standards - 34 ppm

Sediment Cleanup Standards - 48 ppm

Concentrations in Soils/Sediments

Wilderness Lake, Ontario - 0.023 ppm

Woods Lake, Adirondacks - 0.016 to 0.93 ppm

Buzzards Bay - 0.12 to 0.96 ppm

Charles River, Boston - 13 ppm (maximum)

Concentrations in Norwegian Soils

Unpolluted Soils - mean 0.0197 ppm

Unpolluted Bog Soils - mean 0.0897 ppm

Soils Polluted by Total PAH - mean 0.459 ppm

TABLE 27
(Continued)

STANDARDS AND DATA SUMMARY FOR
PYRENE

Other NED Projects

Contaminated Sediments¹

West Thompson Lake, CT - 1.3 to 3.4 ppm

Lightly Contaminated Sediments

Thomaston Dam, CT - 2.4 to 4.8 ppm

Hop Brook Lake, CT - 0.64 to 2.0 ppm

Clean Sediments

Otter Brook Lake, NH - J 0.094 to 0.58 ppm

Mean at Other NED Projects - 1.9 ppm

Notes:

J - Estimated value; analyte detected at less than the
Practical Quantitation Limit.

¹Pollutional classification of sediments is based on their
overall condition; these sediments were not necessarily
contaminated with pyrene.

TABLE 28

STANDARDS AND DATA SUMMARY FOR
BIS(2-ETHYLHEXYL) PHTHALATE

Range at Barre Falls Dam

Water - <0.00067 to <0.00071 ppm (Blank - J 0.00082 ppm)

Sediment - <0.39 to J 0.38 ppm

Drinking Water Standards

Primary - NA

Secondary - NA

MCLG - 0.004 ppm (proposed)

Freshwater Aquatic Life Criteria

Acute - 0.40 ppm

Chronic - 0.36 ppm

CT DEP Freshwater Human Health Criteria

Consumption of Organisms only - 0.0059 ppm

Consumption of Water and Organisms - 0.0018 ppm

Biological Sediment Effects - NA

Sediment Management Standards for the State of Washington

Normalized on a Total Organic Carbon (TOC) Basis

Sediment Quality Standards - 47 ppm

Sediment Cleanup Standards - 78 ppm

Assuming sediment TOC concentration is 8.9%

Sediment Quality Standards - 4.2 ppm

Sediment Cleanup Standards - 6.9 ppm

Assuming sediment TOC concentration is 3.4%

Sediment Quality Standards - 1.6 ppm

Sediment Cleanup Standards - 2.65 ppm

Concentrations in Soils/Sediments

Portland, Maine coastal sites - 0.06 to 7.8 ppm

Other NED Projects

Contaminated Sediments¹

West Thompson Lake, CT - <0.13 to J2.2 ppm

Lightly Contaminated Sediments

Thomaston Dam, CT - 0.14 to 0.98 ppm

Hop Brook Lake, CT - 0.41 to 0.52 ppm

Clean Sediments

Otter Brook Lake, NH - <0.053 to 0.10 ppm

Mean at Other NED Projects - 0.62 ppm

Notes: J - Estimated value; analyte detected at less than the Practical Quantitation Limit.

¹Pollutional classification of sediments is based on their overall condition; these sediments were not necessarily contaminated with bis(2-ethylhexyl)phthalate.

TABLE 29

STANDARDS AND DATA SUMMARY FOR
BUTYLBENZYLPHTHALATE

Range at Barre Falls Dam

Water - <0.00041 to <0.00044 ppm
Sediment - J0.15 to <0.24 ppm

Drinking Water Standards

Primary - NA
Secondary - NA
MCLG - 0.8 ppm

Freshwater Aquatic Life Criteria - NA

Freshwater Lowest Effects Concentration

Acute - 0.94 ppm
Chronic - 0.003 ppm

Biological Sediment Effects - NA

Sediment Management Standards for the State of Washington

Normalized on a Total Organic Carbon (TOC) Basis

Sediment Quality Standards - 4.9 ppm

Sediment Cleanup Standards - 64 ppm

Assuming sediment TOC concentration is 8.9%

Sediment Quality Standards - 0.44 ppm

Sediment Cleanup Standards - 5.7 ppm

Assuming sediment TOC concentration is 3.4%

Sediment Quality Standards - 0.17 ppm

Sediment Cleanup Standards - 2.2 ppm

Concentrations in Soils/Sediments

Chesapeake Bay - ND

Detroit River - 0.0001 ppm

Illinois River - 0.0006 to 0.0009 ppm

Lake Superior - 0.0004 to 0.00045 ppm

Lake Erie - 0.0004 to 0.00042 ppm

Lake Huron - ND

Other NED Projects - ND

Notes:

J - Estimated value; analyte detected at less than the
Practical Quantitation Limit.

TABLE 30

STANDARDS AND DATA SUMMARY FOR
DIETHYLPHTHALATE

Range at Barre Falls Dam

Water - 0.00058 to J 0.00027 ppm

Sediment - 0.38 to 1.1 ppm (Blank - 0.053 ppm)

Drinking Water Standards

Primary - 5 ppm (proposed)

Secondary - NA

MCLG - 5 ppm (proposed)

Freshwater Lowest Effects Concentration

Acute - 0.94 ppm

Chronic - 0.3 ppm

Biological Sediment Effects - NA

Sediment Management Standards for the State of Washington

Normalized on a Total Organic Carbon (TOC) Basis

Sediment Quality Standards - 61 ppm

Sediment Cleanup Standards - 110 ppm

Assuming sediment TOC concentration is 8.9%

Sediment Quality Standards - 5.4 ppm

Sediment Cleanup Standards - 9.8 ppm

Assuming sediment TOC concentration is 3.4%

Sediment Quality Standards - 2.1 ppm

Sediment Cleanup Standards - 3.7 ppm

Concentrations in Soils/Sediments

Chesapeake Bay - 0.013 to 0.049 ppm

Chester River, MD - 0.011 to 0.044 ppm

Lake Ponchartrain, LA - 0.025 to 0.065 ppm

San Luis Pass, TX - <0.002 to 0.009 ppm

Average: Range - <2 to 0.065 ppm

Mean - 0.0345 ppm¹

Other NED Projects

Contaminated Sediments²

West Thompson Lake, CT

Sample Range - 0.19 to 1.4 ppm

Method Blank - 0.053 ppm

TABLE 30 (Cont.)

STANDARDS AND DATA SUMMARY FOR
DIETHYLPHTHALATE

Other NED Projects (Cont.)

Lightly Contaminated Sediments

Thomaston Dam, CT - 0.088 to 0.091 ppm

Hop Brook Lake, CT - 0.22 to 0.29 ppm

Clean Sediments

Otter Brook Lake, NH

Sample Range - <0.053 - 0.12 ppm

Method Blank - 0.076 ppm

Mean for Other NED Projects - 0.26 ppm

Notes:

J - Estimated value; analyte detected at less than the Practical Quantitation Limit.

¹Mean calculated taking minimum and maximum concentration reported for each site and averaging.

²Pollutional classification of sediments is based on their overall condition; these sediments were not necessarily contaminated with diethyl phthalate.

TABLE 31

STANDARDS AND DATA SUMMARY FOR
DI-N-BUTYL PHTHALATE

Range at Barre Falls Dam

Water - <0.00044 to <0.00046 ppm

Sediment - 1.7 to 20 (blank - 0.09 ppm)

Drinking Water Standards

Primary - NA

Secondary - NA

MCLG - 0.8 ppm (proposed)

Freshwater Aquatic Life Criteria - NA

Freshwater Lowest Effects Concentration

Acute - 0.94 ppm

Chronic - 0.003 ppm

Biological Sediment Effects - NA

Sediment Management Standards for the State of Washington

Normalized on a Total Organic Carbon (TOC) Basis

Sediment Quality Standards - 220 ppm

Sediment Cleanup Standards - 1,700 ppm

Assuming sediment TOC concentration is 8.9%

Sediment Quality Standards - 20 ppm

Sediment Cleanup Standards - 150 ppm

Assuming sediment TOC concentration is 3.4%

Sediment Quality Standards - 7.5 ppm

Sediment Cleanup Standards - 58 ppm

Concentrations in Soils/Sediments

Chesapeake Bay - 0.027 to 0.089 ppm

Portland, Maine - 0.04 to 0.28, mean 0.16 ppm

Gulf of Mexico

Mississippi Delta - 0 to 0.052, mean 0.013 ppm

Gulf Coast - 0 to 0/15, mean 0.0076 ppm

Open Gulf 0.0016 to 0.0056, mean 0.0034 ppm

Lake Superior - 0.10 ppm

Lake Erie - 0.003 to 0.006 ppm

Lake Huron - 0.29 ppm

Delaware River Estuary - 0.0045 ppm

TABLE 31
(Continued)

STANDARDS AND DATA SUMMARY FOR
DI-N-BUTYL PHTHALATE

Other NED Projects

Contaminated Sediments¹

West Thompson Lake, CT

Sample Range - 2.3 to 49 ppm

Method Blank - 1.4 ppm

Lightly Contaminated Sediments

Thomaston Dam, CT - 0.11 to 0.14 ppm

Hop Brook Lake, CT

Sample Range - <0.042 to 0.26 ppm

Method Blank - 0.27 ppm

Clean Sediments

Otter Brook Lake, NH

Sample Range - 0.14 to 0.26 ppm

Method Blank - 0.10 ppm

Overall Mean for Other NED Projects - 4.6 ppm

Notes:

J - Estimated value; analyte detected at less than the
Practical Quantitation Limit.

¹Pollutional classification of sediments is based on their
overall condition; these sediments were not necessarily
contaminated with di-n-butyl phthalate.

TABLE 32

STANDARDS AND DATA SUMMARY FOR
ISOPHORONE

Range at Barre Falls Dam

Water - <0.00034 to <0.00036 ppm

Sediment - <0.20 to J0.27 ppm

Drinking Water Standards

Primary - NA

Secondary - NA

MCLG - NA

Freshwater Aquatic Life Criteria - NA

Acute - 117 ppm

Chronic - NA

Biological Sediment Effects - NA

Sediment Management Standards for the State of Washington

Normalized on a Total Organic Carbon (TOC) Basis

Sediment Quality Standards - NA

Sediment Cleanup Standards - NA

Other NED Projects

Contaminated Sediments¹

West Thompson Lake, CT - <0.39 ppm

Lightly Contaminated Sediments

Thomaston Dam, CT - <0.050 ppm

Hop Brook Lake, CT - <0.051 ppm

Clean Sediments

Otter Brook Lake, NH - <10 ppm

Notes:

J - Estimated value; analyte detected at less than the
Practical Quantitation Limit.

¹Pollutional classification of sediments is based on their
overall condition; these sediments were not necessarily
contaminated with isophorone.